

Appendix C

List of Commenters

The following individuals and organizations provided comments during the scoping period for the EIS. In addition, the Environmental Protection Agency (EPA) provided preliminary scoping comments on the EIS and MSHCP in May 2015. The following table lists each commenter, their affiliation, the date the comment was received, and the source through which the comment was received. A copy of all comments received during the scoping period are provided in Appendix D.

List of Commenters

No.	Commenter	Affiliation	Date	Source
1	Terry McGovern	Individual	7/21/2015	Regulations.gov
2	Jim Bembinster	Individual	7/16/2015	Regulations.gov
3	Tom Stacy	Individual	7/23/2015	Email
4	Julia Johnson	Individual/Union Neighbors United	7/21/2015	Comment form and Email
5	James E. Krause	Individual	7/20/2015	Comment form
6	Laurie Werner	Sheboygan County Communities for Responsible Energy	7/15/2015	Email
7	Berkshire Hathaway Energy	Berkshire Hathaway Energy	8/11/2015	Regulations.gov
8	Bat Conservation International	Bat Conservation International	8/11/2015	Regulations.gov
9	Alexis Andiman	Conservation Law Center	8/11/2015	Regulations.gov
10	Kandace Andriadis	Individual	8/11/2015	Regulations.gov
11	Anonymous	Individual	8/10/2015	Regulations.gov
12	L. Menefee	Individual	8/10/2015	Regulations.gov
13	Scott Davis	The Nature Conservancy	7/29/2015	Regulations.gov
14	Erin Basiger	Indiana Department of Natural Resources	8/11/2015	Emailed letter
15	EPA	U.S. EPA Regions 5 and 7	8/11/2015	Emailed letter
16	C G Spies	Individual	6/17/2015	Emailed letter
17	EPA	U.S. EPA Regions 5 and 7	5/21/15	Email

Appendix D

Scoping Comments



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

For related information, [Open Docket Folder](#) 

[Comment Now!](#)

Due Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0003

Tracking Number: 1jz-8k1m-4ccq

Comment

Industrial wind energy has already been given an incidental take permit for bald and golden eagles, now they want permission to kill millions of bats across our country, including bats already being decimated by white nose disease in the Midwest. Given the species of bats most effected by white nose have only one pup per year and already 50% of pups die each year, the remaining population will become extinct. This is not a 'take permit' it is a extinction permit which goes completely against the Fish and Wildlife's Mission to "...to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." Seeing industrial wind partner with the U.S. Chamber to pressure FWS to make decisions against its core mission and one of its core principles (Threatened and Endangered Species: Achieving Recovery and Preventing Extinction) is troubling. My hope is the men and women of FWS rally behind their mission and core beliefs and not cave to the wind lobbyists who care little about bat habitats. Mike Prior, head of the Iowa Wind Energy Association, told IowaWatch (17 July): "While we want to evolve wind energy in a way not to hurt wildlife, bat deaths are not a concern and will not impact wind energy." (<http://www.spencerdailyreporter.com/story/2214442.html>). Someone has to stand up for the bats as that population has no voice and they are clearly not a concern to the Wind Energy Association.

The environmental impact statement for Midwest Wind Energy Multi-species conservation plan should note that industrial wind turbines kill a wide range of avian species at a disproportionately high rate compared to other man-made structures. This includes endangered species such as our national symbol, the bald eagle, and other protected species at a rate that could cause extinction for populations already dealing with other life-threatening circumstances. Hence hours of operations, minimum wind speed activation,

Document Information

Date Posted:

Jul 21, 2015

[Show More Details](#) 

Submitter Information

Submitter Name:

Terry McGovern

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52041

location, tower heights, and all other means necessary to dissuade bats, local avian populations and migratory populations from flying near industrial turbines must be exhausted. I'd like to see some commentary related to a percentage of annual revenue generated by wind farms returned to local county conservation boards to allow for bat / bird habitat support and conservation in other areas of counties far removed from the turbine kill zones. Finally, I believe the impact statement must include commentary about the expected increase in pesticide use as bat populations are thinned. Considering this systemically, the negative ecological impact of greater pesticide usage should also be noted on bee populations which are greatly stressed now, as well as other species, and human health impacts as well.

As a final note, it is unethical to create a policy then ignore it or provide purchased waivers to it. Threatened and Endangered Species guidelines are clear--to allow one industry limitless kills of protected species is wrong. It is especially wrong when the industry is killing birds, bats, and raptors at a rate never before seen by a single man-made structure. When is too many too many? Is there an acceptable number or percentage of avian populations we are comfortable with destroying? All this for an energy source that is grossly inefficient, astronomically expensive, and has only a token impact on the global carbon problem.



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

For related information, [Open Docket Folder](#) 

Comment Period Closed

Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0002

Tracking Number: 1jz-8k0d-9lwy

Document Information

Date Posted:

Jul 16, 2015

[Show More Details](#) 

Submitter Information

Submitter Name:

Jim Bembinster

City:

Evansville

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United States

State or Province:

WI

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53536

Comment

Please consider the impact wind turbines have had on bird and bat populations. With all the things that birds and bats must overcome for survival wind turbines are an additional and very serious source of bird and bat mortality.

We Energies Post Construction Bird and Bat mortality report:

This report from the Blue Sky/Green Field wind project in Fond du Lac County, Wisconsin shows that wind turbine related bat kills at 41.5 kills per turbine per year is ten times higher than the predicted average of 4 kills per year. The state of Wisconsin is tied only with Pennsylvania as having the highest wind turbine related bat kills in North America. One could question the accuracy of this report as it is provided by the violator as self reported. My opinion is you could increase the kill numbers by a factor of 2.5 and be close to real time conditions.

This report is only a best guess based on what could be found. Birds and bats killed by turbines would be difficult to find in a corn or soy bean field. There would not be much left to find of a bird or bat hit by a turbine blade moving 175 MPH. I am sure you are well aware that bats do not have to be struck by the blades to be killed, they need only fly into the low pressure area behind the turbine blades. The low pressure area behind the turbine blades will cause the bats lungs to rupture. Barotrauma is a significant cause of bat deaths and may help explain the high fatality rates in Wisconsin.

Also please consider the negative impact to agriculture by the reduced bat populations.

If Wisconsin reaches its RPS with wind turbines by 2025 bat kills would increase to 500,000 per year minimum. Bats will never overcome this high kill rate.

Curtailment should be considered at night during the months that the majority of bat kills occur. Bird and bat detection radar is also available and was tested in Wisconsin years ago. But never implemented, why?

The wind industry wants no restrictions and in their opinion no sacrifice is too great so that they can sell wind turbines. No industry should be given the right to kill anything under any circumstances.

The idea that the wind industry be given a permit to kill birds and bats is outrageous. With the wind industry its take, take, take, with no end in sight. Just say no.

Thank you for your time and consideration,

Jim Bembinster
18002 W Cr C
Evansville, WI 53536

----- Forwarded message -----

From: **Tom Stacy** <tfstacy@gmail.com>

Date: Thu, Jul 23, 2015 at 6:29 PM

Subject: Re: Wind energy minimum cut-in speed strategy financial implication estimation methodology

To: rick_amidon@fws.gov

I would like to retract and replace the attachment provided in my previous email. Please refer to the attached PDF document in lieu of the original Word attachment. Thank you.

On Thu, Jul 23, 2015 at 7:26 PM, Tom Stacy <tfstacy@gmail.com> wrote:

Hi Rick,

After attempting to reach you by telephone today I drafted this sample document for your and the Service's initial consideration. I was referred to you by Ms. Julia Johnson, a board member of Union Neighbors United located in Champaign County, Ohio. Ms. Johnson attempted to convey a data acquisition roadblock potentially preventing the US Fish and Wildlife Service (Service) from confidently estimating the economic impact of increased cut-in speed curtailment to 6.5 m/sec. at specific date ranges and hours of day.

Please have a look at the attached draft procedure, opinion and recommendations. I would be interested in your feedback regarding how I might better understand the Service's needs and whether I might be sufficiently qualified to help it meet some of its needs.

Thank you.

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Tom Stacy

6628 County Road 10

Zanesfield, Ohio

[\(937\) 407-6258](tel:9374076258)

Co-Author: [The Levelized Cost of Existing Generation Resources, 2015](#)

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Tom Stacy

Estimating Revenue and Profit Impacts of Seasonal/Diurnal Low-Wind Curtailment (Rotor Immobilization) Strategy vs. Facility Lifespan Estimated Endangered Species Takings Fines for Planned Wind Energy Facilities

Working draft/proposal for US Fish and Wildlife Service, July 23rd, 2015
by Tom Stacy - All rights reserved.

This document is proprietary and is offered strictly to facilitate an offer to provide consulting services. Some aspects and combinations of the above materials represent the intellectual private property of Tom Stacy, and are made available on consignment only for purposes of considering contracting his services. A complete peer reviewed vetting of this procedure along with calculation templates may be procured from Mr. Stacy upon request. Further consulting services related to this matter are also available. Thank you.

As I understand it, the US Fish and Wildlife Service is tasked with protecting endangered species without preferential bias for or against particular hazards specific to particular technologies. In the case of industrial wind energy, certain protected or endangered avian species are at risk of incidental takings by wind energy machinery, with a higher risk below a certain wind speed and during hours of the year in which certain species are expected to undertake certain airborne activities at the ground elevation of wind turbine rotor swept areas.

I also interpret from outside sources that one risk mitigation strategy USFWS has employed is to increase the minimum wind speed at which wind turbine rotors are permitted to spin during certain aerial activity times of day and seasons of the year. Specifically, a 6.5 meter per second (m/sec) wind turbine “cut-in speed” (the speed at which the wind turbine begins to produce electricity) during such periods has been employed and/or is a standard protocol of the mitigation strategy offered by the US Fish and Wildlife Service (USFWS). It should be noted here that under design conditions wind turbine rotors begin SPINNING at wind speeds somewhat lower than at which they begin producing electricity. The concern of USFWS is with wind turbine rotors SPINNING, as it is the motion, not the electricity generation, which may be most pertinent to the risk level to the species.

As I interpret the situation, a concern has been raised by wind project developers that a higher minimum cut-in speed strategy impedes revenue and thereby potentially impedes project viability. The question may have been raised by USFWS as to the specific revenue and profit implications of the wind speed cut-in speed curtailment strategy at specific wind speed minimums. The answers would of course be specific to a proposed wind project in a specific location using a specific wind turbine model with a specific tower height, and what those implications are at various proposed minimum cut-in speeds (i.e. 5.5m/sec, 6.0 m/sec, 6.5 m/sec). Project developers may have been reluctant to answer this specificity of question, citing “competitively sensitive and proprietary information” concerns.

The answer to USFWS’s question can certainly be estimated. Moreover, it can be most closely estimated using a collection of public and “proprietary” sources of data. However it can be estimated to a lower confidence level in the absence of project specific proprietary anemometer data sets by extrapolating from a collection of reference anemometer data sets which may be available or made available to

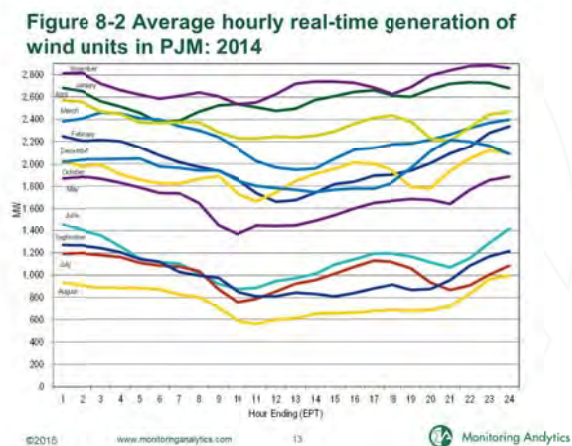
USFWS through internal or external sources. For example, it seems likely the US government has deployed anemometers and other wind speed data collection equipment at various locations around the US. Such data should be public and furthermore should be available to USFWS.

However, USFWS obtaining project specific anemometer data sets for a specific use under limited proprietary conditions can be argued to be a reasonable request of the take permit applicant, and refusal to comply with such request would seem reasonable grounds on which to simply enforce incidental takings fines schedules in lieu of developing a HCP and/or issuing an incidental take permit. US Fish and Wildlife Service does (or should) hold decision making authority, and clearly has no partiality for any particular wind energy developer, turbine manufacturer or wind energy project. USFWS should therefore be granted (by the developer or if necessary, by court order) limited use access to anemometer data from a take permit or HCP applicant because the data set is germane to independently verifying the revenue and profitability impact developers argue the cut-in speed minimum strategy might impose. It should be argued by USFWS that the existence of revenue and profit impact does not necessarily translate to project unviability, and therefore should not be as compelling to USFWS or a court of law as estimating revenue and profit impact using best available data – including project specific anemometer data the project developer has already likely collected.

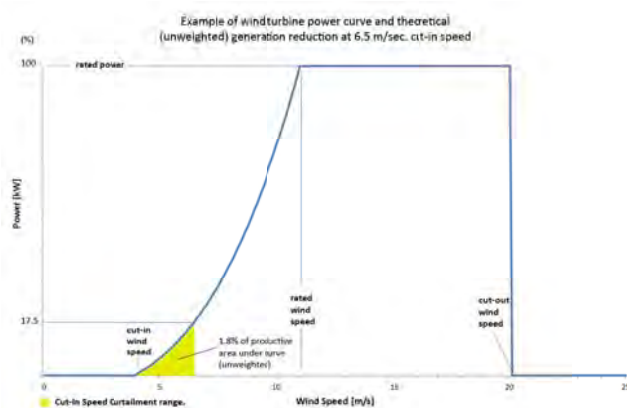
The following draft procedure assumes USFWS has gained access to at least one full year of contiguous hourly anemometer data for the proposed turbine hub height at the proposed project site. A second procedure and list of recommended data sources can be compiled should USFWS be unsuccessful at persuading the developer (or the court) to allow limited access to anemometer data in order to verify revenue/profit impact claims of the developer.

Each of the following numbered items need to be checked across a draft spreadsheet application using some real or fictional data sets. Then each procedural step should be detailed in sub-steps.

1.) Obtain hourly average wind speed data for an historical entire year (or more) at proposed tower height at the proposed facility location (anemometer data). The developer has this data. A purpose-specific, confidential use of the data should be obtainable given the USFWS has the right to deny take permit.



2.) Obtain a tower height specific power curve for the proposed wind turbine model (typically available in the manufacturer's detailed specification sheet). Obtain a power curve reflecting net generation per turbine. Contact manufacturer if unsure of this qualification. For instance, some low wind speed turbine models may periodically consume energy at or just below cut-in speed to "spin up" rotors to overcome static inertia in order to reduce cut-in speed. Ask manufacturer for a power curve for new blades, rotor bearings and wear plates and gear sets/bearings and for used components at component end of service life. Frictional resistance rises as components age, raising realized cut-in and/or decreasing net power generation near cut-in speed over time. Average the new and end-of-life figures. Manufacturers should have and be willing to share such data. Also ask the manufacturer at what speed the rotor may begin to spin but not produce power (freewheeling). This may factor into USFWS estimated takings analysis.



Derived from sample power curve: <http://www.elm.eri.ac.uk/ins4.html>

3.) Use a spreadsheet application to construct a table which converts hourly average wind speed data into theoretical power (KW) (for each 0.25 meter per second increment - using numerically interpolated power curve data). Apply de-rate factor for wind direction variability and gustiness (wind rose interpretation). This should also be available through the machinery manufacturer (but not necessarily through the project developer directly). Ask manufacturer for a "reference project" with a full calendar year operational history using same or similar turbine configuration in a similar wind regime. Look up the annual capacity factor of that project for a recent historical year (or years) using DOE EIA Form 923 records. The de-rate application and EIA 923 data together provide a "sanity check" between theoretical and historically realized annual capacity factors. Make a determination of hourly and annual generation based on the above data sources. Seek input from the turbine manufacturer.

4.) For each hour of the year, apply the table above using logical function sumrange, sumif (Excel) or a pivot table to arrive at modeled hourly wind generation over a full year (or more).

5.) Obtain from the regional grid operator the hourly average wholesale price information for the most recent one year (or more) for the LMP zone where the proposed wind facility would be constructed. (Proprietary use agreement may be required. USFWS should be able to justify limited use access for this purpose.)

6.) Multiply each hour's LMP value by the corresponding hour of the year wind generation to arrive at theoretical hourly (A.) and annual (B.) (sum of 8,760 hourly values) wholesale energy market revenue.

7.) Determine the present value of lifespan annual power purchase agreements, production, renewable energy certificate (REC) subsidies and any other production-dependent revenue sources and divide that present value by the theoretical lifetime energy generation (sum of the 8,760 results in procedural step 4.) times the physical lifespan in years (see (10.)) to arrive at total levelized out-of-market revenue per MWh. Be certain to use the pre-tax value of tax subsidies $[(\text{subsidy amount}) / (1 \text{ minus the expected corporate tax rate})]$ Note: To calculate annual gross revenue percentage impact It will be necessary to also consider separately revenue sources which are not production dependent.

8.) Add 7.) + 8.) to arrive at theoretical total pretax revenue without curtailment

9.) Use sumifs function (date range, hour of day range, wind speed curtailment level) to total the foregone estimated annual generation (4.) and revenue (6.A.)

10.) Estimate the levelized cost of energy (LCOE) from the project over an assumed physical lifespan (20 to 25 years or by agreement with developer and turbine manufacturer)

11.) Subtract 8.) – 9.) to arrive at estimated annual project revenue at regulated curtailment requirement

12.) Subtract LCOE (10.) from theoretical total revenue without curtailment (8.) to arrive at uncurtailed annual profit, year 1 without curtailment.

13.) Subtract LCOE from theoretical total revenue with curtailment to arrive at annual profit, year 1 with curtailment.

14.) Apply present value calculations as deemed appropriate to arrive at levelized pre-tax profit over facility estimated physical lifespan

15.) Compare cost from (14.) to present value of lifespan estimated endangered species takings fines. The service might explore a cut-in speed which achieves a revenue-neutral result between PV of cost of fines and PV cost of cut-in speed curtailment over physical lifespan of facility.

This document is proprietary and is offered strictly to facilitate an offer to provide consulting services. Some aspects and combinations of the above materials represent the intellectual private property of Tom Stacy, and are made available on consignment only for purposes of considering contracting his services. A complete peer reviewed vetting of this procedure along with calculation templates may be procured from Mr. Stacy upon request. Further consulting services related to this matter are also available. Thank you.

Tom Stacy, 6628 County Road 10, Zanesfield, OH 43360 (937) 407-6258 tfstacy@gmail.com

Environmental Impact Statement for the

Midwest Wind Energy Multi-Species Habitat Conservation Plan

How Do I Submit Comments?

- **Written Comments:** Complete and submit this form at a public meeting, or mail your comments to the U.S. Fish and Wildlife Service address at the bottom of this page.
- **Electronic Comments:** Submit electronic comments by visiting the Federal eRulemaking Portal: www.regulations.gov. In the search box enter (Docket Number FWS-R3-ES-2015-0033).

Please refer to Docket No. FWS-R3-ES-2015-0033 in all correspondence.

Scoping comments must be postmarked by August 11, 2015 to be considered in the Draft EIS.

SEE ATTACHED

NOTE: Before including your address, phone number, e-mail address, or other personal identifying information, you should be aware that your personal identifying information may be made publicly available at any time.

NAME:

ADDRESS:

CITY, STATE, ZIP CODE:

PHONE:

E-MAIL:

Comments may be submitted
today or mailed to:

Regional Director,
Attn: Rick Amidon
U.S. Fish and Wildlife Service,
Ecological Services
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

COMMENTS OF JULIA F. JOHNSON
ON BEHALF OF OHIOANS
CONCERNING
THE MIDWEST WIND ENERGY MULTI-SPECIES HABITAT CONSERVATION PLAN and
THE INCIDENTAL TAKE OF MIGRATORY BIRDS

July 21, 2015

Thank you for the opportunity to present the concerns of Ohioans pertaining to the Environmental Impact Statement for the proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan. My name is Julie Johnson and I am here to speak on my own behalf as well as for others in Champaign County who are a part of a community-based organization known as Union Neighbors United. I am also representing the interests of a larger coalition of Ohioans from Allen, Auglaize, Greene, Logan, Lucas, Hardin, Mercer, Crawford, Putnam, Shelby, Huron, Richland, Cuyahoga, Franklin, Seneca, Paulding and Van Wert counties. We have several points of concern which I would like to address:

1. A Balanced Assessment

The US Fish and Wildlife Service (the "Service") has a duty to undertake a balanced inquiry into the benefits and costs associated with wind turbine development. It has been our observation that the alleged benefits put forward by the wind industry are accepted without examination or challenge. This unfairly puts the onus on the public to refute industry's claims. But the duty to undertake a balanced inquiry belongs to USFWS and it is incumbent upon you to articulate the basis for your findings. Your obligation to protect endangered species must be paramount in the design of any HCP. The law requires the agency to take maximum feasible measures to avoid harm. Should USFWS decide to accept less than this standard, the public has the right to know what scholarship underpins your decision and the public has a right to challenge such decisions.

In a June 25, 2015 interview with the Financial Times, retired Microsoft CEO, Bill Gates asserted that current technologies such as wind and solar could only reduce global emissions at a "beyond astronomical" economic cost. He has invested billions of his own funds into research and development to create a means by which to reliably generate power because current renewable technology cannot. It is likely that within the coming decade there will new, breakthrough clean technologies. If Gates is correct, wind power is not now and nor will it in the future be viable as a means to address climate change. The empty promise of a clean technology that is both unaffordable and unreliable does not justify diminished protections for species like the Indiana bat, the little brown bat or, more recently, the northern long-eared bat. We have provided a list of links to studies which the agency should consider in looking at the other side of this two sided "benefit" equation.

In addition to the recognition that wind cannot reliably power today's economy, the real experiences of people across the globe demonstrate harms to people, the landscape, property values and wildlife. Both the U. K. and Australia have announced plans to end wind subsidies. In the U.S., states are reconsidering their renewable mandates and some have already been repealed as it becomes increasingly clear that mandates kill industry, cost jobs and wreak havoc on critical market signals. Moreover, states like Ohio

are customer choice states wherein consumers can choose the kind of power generation they want from any generator in the grid operator's system. Also important to note is that Ohio's in-state renewable portfolio mandate, often cited as a reason to build wind in Ohio, was repealed entirely in 2014. Renewable mandates do not provide a justification for inadequate protective measures. The increasing evidence of state mandate repeals in Region 3 should eliminate this as a basis for approving projects or allowing wind development operators to take less than the maximum feasible steps to protect the Indiana, Little Brown or Northern Long Eared bat.

With respect to siting, there is no basis for siting a damaging wind facility in an area where the presence of protected species are known to be present. In August 2009, Ohio Department of Natural Resources Biologist Keith Lott wrote that pre-construction mist surveys along the Bellefontaine ridge in central Ohio identified 8 Indiana bat maternity colonies comprised of several hundred individuals. (Letter attached) At least one additional maternal roost colony of Indiana bats was later documented in Champaign County by Invenergy. Places inhabited by known endangered or threatened species should be places where the USFWS **discourages** wind development. They should not be places where USFWS seeks to lower the standard for protection or where take permits should be expedited. When viewing the range of Indiana bats within the states of Region 3, there is significant overlap. It should be incumbent on USFWS to provide national leadership in following the requirements of the Endangered Species Act.

Within Ohio there are at least five identified hibernacula and numerous maternal roost colonies. Banding has shown that bats travel to Central Ohio from Kentucky to summer and many fly through the area en route to Michigan. White Nose Syndrome is being documented in more Ohio counties. The lethal combination of wind development and WNS was the subject of a study by Thomas Kunz, Warren Distinguished Professor in Boston University's Department of Biology in 2011 entitled The Economic Importance of Bats in Agriculture. (<http://www.sciencemag.org/content/332/6025/41.short>) The release accompanying the report noted that:

"Pest-control services provided by insect-eating bats in the United States likely save the U.S. agricultural industry at least \$3 billion a year, and yet insectivorous bats are among the most overlooked economically important, non-domesticated animals in North America, noted the study's authors, scientists from the University of Pretoria (South Africa), the U.S. Geological Survey (USGS), the University of Tennessee, and Boston University."

"People often ask why we should care about bats," said Paul Cryan, a USGS research scientist at the Fort Collins Science Center and one of the study's authors. "This analysis suggests that bats are saving us big bucks by gobbling up insects that eat or damage our crops. It is obviously beneficial that insectivorous bats are patrolling the skies at night above our fields and forests— these bats deserve help."

"The value of the pest-control services to agriculture provided by bats in the U.S. alone range from a low of \$3.7 billion to a high of \$53 billion a year, the authors estimated. They also warned that noticeable economic losses to North American agriculture could well occur in the next 4 to 5 years because of the double-whammy effect of bat losses due to the emerging disease white nose syndrome and fatalities of

certain migratory bats at wind-energy facilities. In the Northeast, however, where white-nose syndrome has killed more than one million bats in the past few years, the effects could be evident sooner.”

“Bats eat tremendous quantities of flying pest insects, so the loss of bats is likely to have long term effects on agricultural and ecological systems,” said Justin Boyles, a researcher with the University of Pretoria and the lead author of the study. “Consequently, not only is the conservation of bats important for the well-being of ecosystems, but it is also in the best interest of national and international economies.”

A single little brown bat, which has a body no bigger than an adult human thumb, can eat 4 to 8 grams (the weight of about a grape or two) of insects each night, the authors note. Although this may not sound like much, it adds up—the loss of one million bats in the Northeast has probably resulted in between 660 and 1320 metric tons of insects no longer being eaten each year by bats in the region.

“Additionally, because the agricultural value of bats in the Northeast is small compared with other parts of the country, such losses could be even more substantial in the extensive agricultural regions in the Midwest and the Great Plains, where wind-energy development is booming and the fungus responsible for white-nose syndrome was recently detected,” said Kunz.

Although these estimates include the costs of pesticide applications that are not needed because of the pest-control services bats provide, Boyles and his colleagues said they did not account for the detrimental effects of pesticides on ecosystems or the economic benefits of bats suppressing pest insects in forests, both of which may be considerable.”

The data in this study provide an average value of \$74 per crop acre in avoided pesticide costs to farmers by bats. In Champaign County *alone* this equates to a \$12 million annual cost to farmers. Region 3 is home to a significant share of the nation’s agricultural industry. The value of this industry and its impact on the nation’s economy dwarf any value attributed to the wind industry. It is incumbent upon USFWS to protect the bat population using maximum feasible strategies. If the wind industry chooses to site a wind facility in an area populated by endangered or threatened bats, they must be held to the highest possible standards for avoidance. More often than not, siting considerations are made with proximity to transmission as an overriding factor in order to reduce costs and enhance developer profitability. Yet the potential cost to the farming community is real and must be considered if making a fair assessment of an HCP.

2. Land Use

In 2008, The Wildlife Society issued a position paper on “The Impacts of Wind Energy Development on Wildlife and Wildlife Habitat” in which they noted that “Impacts resulting from loss of habitat for wildlife due to construction of turbines, access roads, and power transmission networks, the footprint of the turbine facilities, and increased human access are important and should be considered. Ultimately, the greatest influence from habitat modification on wildlife may be due to disturbance of habitats in proximity to turbines and fragmentation of habitat for wide ranging species.” and “Given the projected increasing development of wind energy, biologically significant cumulative impacts are possible for some species and may become more pronounced over time unless solutions are found. Avoiding, minimizing, and mitigating

harmful impacts to wildlife are important elements of "green energy" and it is imperative that developers of wind energy, scientists, and natural resource agency specialists cooperate in developing and testing methods to minimize harm to wildlife." (Attached)

Because the power density of wind is so poor, the Nature Conservancy coined the phrase "energy sprawl" to describe the large tracts of land required for the production and transportation of energy derived from wind. This sprawl creates unprecedented fragmentation and disturbance of the landscape. In his book, "Power Hungry," author Robert Bryce discusses this impact in Chapter 8. Bryce documents that wind power requires about 45 times as much land to produce a comparable amount of power as nuclear, 4 times as much as natural gas and 7 times as much as coal.¹ In Champaign County, one wind project is expected to cover 64 square miles. Given the extraordinary land use impacts, stringent measures to protect species are necessary. There is no justification for exacerbating the harm of fragmentation and disturbance by diluting known strategies for avoidance.

3. Disparate Treatment

We object to enabling certain wind turbines within one defined project area to operate under differing protocols. If the presence of a protected species has been documented in pre-construction monitoring, all wind turbines within the project action area should be required to adhere to the same rules of operation such as cut-in speeds or curtailment. In some instances, wind developments are scattered across a wide geographic area due to the unwillingness of area residents to negotiate lease agreements. This may be an indicator of a community's rejection of the developer's siting plan. Notwithstanding, it is the developer's decision to go forward in such areas and it is not up to the USFWS to facilitate the development by permitting some turbines to operate under different standards than others. If a developer chooses to go forward, fragmenting a large geographic area, they should not be assisted in that pursuit by USFWS allowing less effective protections for endangered or threatened species. Many rural areas of Region 3 are densely populated such that habitat fragmentation is already an issue. To facilitate greater fragmentation at the expense of protected species by allowing varying rules for individual turbines is unacceptable.

4. Turbine Model Substitution

Wind turbine technology continues to evolve as the industry seeks to penetrate areas with moderate to poor wind resources. Tower hub heights are increasing while blade lengths are growing longer. In some instances longer blades are installed on shorter towers to keep the overall height roughly the same as that of the originally permitted wind turbines. Notwithstanding, longer blades significantly increase the rotor diameter's sweep area. A larger sweep area poses a greater threat to bats than a smaller sweep area both from a collision risk and barotrauma.

On March 6, 2012, Kevin Lager Murray, Ph.D. presented Bat and Wildlife Issues at Wind Energy Projects in the Midwest to the American Wind Energy Association's Regional Wind Summit in Chicago. At Page 6

¹ Power Hungry, Robert Bryce page 84.

of Dr. Murray's presentation he stated "Larger turbines cause more fatalities." It is a concern that the USFWS would approve an HCP for any industrial wind development where one model is presented and later is substituted for a different model without public notice, a new analysis and more stringent protective measures attaching to the plan. While this is a present concern, it is also a concern under a 45 year permit term given the lifespan of a turbine is currently twenty years or less and the likelihood of repowering.

5. Monitoring

It is widely accepted that finding dead bats at wind facilities is extremely difficult. Models that estimate bat kills should be considered in connection with monitoring. Failure to physically locate bat carcasses should *not* be construed as evidence of successful avoidance. Rather, failure to locate carcasses should prompt a review of the sufficiency of monitoring including frequency and areas selected for monitoring. Independent third parties not employed by the wind companies but contracted by USFWS or state wildlife officials and paid for by the wind companies should be required. The inherent conflict of monitors whose job security may depend on the wind company would call into question the integrity of any monitoring report.

Initially, monitoring should be comprehensive, frequent and aggressive. If, after five years, the practices employed by the wind company to avoid bat fatalities are demonstrated to be effective, consideration could be given to modifying the monitoring protocol. It is not acceptable to begin with a less than fully rigorous protocol and to increase its rigor or frequency subsequent to finding dead bats. Each bat kill reduces the population subject to harm. Declines in populations, possibly exacerbated by White Nose Syndrome, argue for a regime that starts aggressively and earns the right to less monitoring rather than starting with less and having to increase activity following discovery of dead bats. It would be like closing the barn door after the cows have escaped.

It should be noted that, prior to the introduction of the wind industry in Ohio, documentation of summer bat distribution was poor. Newly documented maternal roost colonies have been identified in Champaign, Logan and Hardin for the Indiana bat. It stands to reason that the more one looks, the more one is apt to find the presence of protected bat species. Thus, the monitoring program requirements of the MSHCP must be rigorous at the preconstruction and post construction phases.

6. Siting

There is ample evidence that the wind industry cannot stand alone as a profitable industry and it requires concessions from every level of government – local, state and federal. At the local level the industry seeks significant tax abatement. At the state level, they seek mandates for the use of their output irrespective of price. At the federal level they seek billions in Production Tax Credit subsidies. We can add the relaxation of the Endangered Species Act, expedited processing, unreasonably long take permits and concessions on maximum feasible avoidance strategies to the list of requested concessions. It is not the job of the Service to enhance the profitability of the wind industry. It is your job to protect species.

Should a developer choose to site a project in a bat sensitive area, they be willing to pay the price to do so.

All wind developers should consult with USFWS prior to making siting decisions. Issues concerning cumulative impacts as well as documentation of species and species threats should be factored into a developer's decision making. It is important that this be evaluated prior to siting as opposed to asking for concessions after the fact.

Finally, the reliance on compensation strategies such as investment in land conservation far from the impacted area, does nothing to compensate farmers for the loss of bats and resulting economic injury documented in the Boston University study.

7. Cut-In Speed

The minimum cut-in speed must be initially at least 6.5 mps. This has been demonstrated to provide the most effective means by which to avoid bat fatalities. As noted above, a balanced consideration of all factors, including the economic impact to farmers should not be trumped by a developer's or investor's desire to enhance profitability. The subsidies and concessions required to make wind generation "commercially viable" are endless. Raising the cut-in speed to at least 6.5 mps will not make or break a project that principally relies on massive tax abatement, taxpayer subsidy and government imposed mandates.

Given the spread of White Nose Syndrome, the protections offered by a 6.5 mps cut-in speed are justified and, indeed, warranted.

8. Curtailment/Adaptive Management

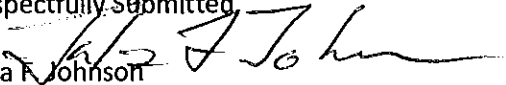
We believe that curtailment is an important strategy for any Adaptive Management program and that, if bat fatalities meet or exceed anticipated counts during any year, curtailment must be considered as a necessary step. By curtailment, we mean shutting down the turbines during critical periods or times of day irrespective of wind speed. As noted above, the costs of curtailment must be considered in a balanced way and decisions of the USFWS must set forth the bases for these decisions including the scholarship underlying them.

9. Prospective Concerns

The Northern Long-Eared Bat ("NLEB") is prevalent in Region 3 and it is possible that it could be upgraded from a Threatened Species to an Endangered Species. There is also documentation of the increasing spread of White Nose Syndrome across a wider geography including the Central Ohio area. It is likely that the cumulative effect of WNS and the proliferation of more wind developments could accelerate risk of harm to protected species. In Ohio, there are 22 wind projects pending in the queue for grid operator PJM, in Illinois there are 36 and in Indiana 21. This represents a significant amount of new development. The MSHCP should articulate that steps will be taken to ensure every wind development project acknowledges the risk environment may change and require them to implement more stringent

protective action, including curtailment. In the Hardin, Logan and Champaign county areas, there are numerous proposed wind projects. This area has also been documented as the location of Indiana bat maternal roost colonies. The MSHCP must consider the cumulative impact of each new proposal and incorporate this thinking into development of maximum feasible steps to avoid bat kills.

Respectfully Submitted


Julia R. Johnson
P.O. Box 230
Urbana, Ohio 4307B
(937) 653-8355

On behalf of Ohio Citizens from the following Counties:

Allen
Auglaize
Champaign
Greene
Logan
Lucas
Hardin
Mercer
Crawford
Putnam
Shelby
Huron
Seneca
Richland
Cuyahoga
Franklin
Paulding
Van Wert



Ohio Department of Natural Resources

TED STRICKLAND, GOVERNOR

SEAN D. LOGAN, DIRECTOR

Division of Wildlife
David M. Graham, Chief
2045 Morse Rd., Bldg. G
Columbus, OH 43229-6693
Phone: (614) 265-6300

17 August 2009

To all interested parties,

Since 1960 Indiana bat (*Myotis sodalis*) populations have declined by 57% (Clawson 2002). As a result it was placed on the Endangered Species list in 1967. In 2007, the population was estimated to be at 468,184; of which 67% over-winter within USFWS Region 3 (USFWS 2007). Prior to the emergence of White-nose syndrome (WNS), the leading causes of decline were thought to be the loss of suitable breeding and over-wintering habitat.

Indiana bats are considered to be a forest dwelling species (USFWS 2007), foraging along riparian areas, floodplains, wetlands, and upland forests (Cope et al. 1974, Humphrey et al. 1977, Menzel et al. 2001, 2005, Murray and Kurta 2004). Though not usually considered foraging habitat, Indiana bats have been documented spending a considerable amount of time (~50%) feeding over agricultural fields (Menzel et al. 2001, Sparks et al. 2005). Due to the sustained higher wind speeds the focus of much of the development of wind turbine facilities in the Midwest is within agricultural regions.

Much of Region 3 is considered within the range of the Indiana bat (Figure 1). To date no wind energy facility has been constructed when Indiana bats were found during pre-construction monitoring. Though multiple wind turbine facilities have been constructed within the range of the Indiana bat, none have been found during post-construction mortality studies. Two species with similar feeding and migratory strategies have been found struck at wind turbine facilities, the little brown (*M. lucifugus*) and northern (*M. septentrionalis*) myotis (Arnett et al. 2007).

During the summers of 2008 and 2009 pre-construction mist net surveys were conducted at 5 proposed wind turbine facilities along the Bellefontaine ridge in Central Ohio. Due to low human population densities and high wind energy potential the Bellefontaine ridge is one of the most suitable regions for wind development within the state. As a result of these surveys twenty-four Indiana bats were captured. Radio telemetry led to the identification of at least 8 maternity colonies comprised of several hundred individuals. Maternity colonies are typically comprised of less than 100 adult females (Harvey 2002), though 1 site within the state has over 300 individuals (A. Boyer personal comm. 2009). Indiana bats show strong site fidelity (Kurta and Murray 2002), so it is expected that these individuals and their young will return to this ridge each year,

potentially increasing the exposure of bats to turbines and potentially increasing the likelihood of take.

Suitable trees for maternity colonies are dead or dying trees with exfoliating bark, these resources are ephemeral, and new sites need to be located once the previous tree has either fallen or lost its bark. It is unknown how far a colony of bats will wander from the original tree to establish a new colony. The Ohio Department of Natural Resources is proposing monitoring of known colonies of Indiana bats along the Bellefontaine ridge. Emergence counts would be used to track Indiana bat numbers at existing roosts, and radio telemetry would be used to identify alternative roost and core areas of activity. Both pieces of information will be used to avoid and minimize impacts to Indiana bats.

Sincerely,

Keith Lott, Wind Energy Wildlife Biologist

Old Woman Creek Nat'l Estuarine Research Reserve and State Nature Preserve
Ohio Division of Wildlife
2514 Cleveland Road East
Huron, OH 44839
Office phone: 419-433-4601
Cell: 419-602-3141
Fax: 419-433-2851



THE WILDLIFE SOCIETY

5410 Grosvenor Lane • Bethesda, MD 20814-2197

Tel: (301) 897-9770 • Fax: (301) 530-2471

E-mail: twswildlife.org

Final Position Statement

Impacts of Wind Energy Development on Wildlife and Wildlife Habitat

Wind energy is an increasingly important sector of the renewable energy industry and offers promise for contributing to renewable energy portfolios to reduce greenhouse gas emissions from carbon-based sources, which contribute to accelerating climate change. Worldwide, development of wind energy is projected to increase substantially in the next decade; wind energy development increased 27% in 2006 and 45% in 2007 in the U.S. alone. Unfortunately, fatalities of birds and bats have been reported at wind energy facilities worldwide. Large numbers of raptor kills in California and bat kills in the eastern U.S. have heightened concerns for some species and sites. Impacts resulting from loss of habitat for wildlife due to construction of turbines, access roads, and power transmission networks, the footprint of the turbine facilities, and increased human access are important and should be considered. Ultimately, the greatest influence from habitat modification on wildlife may be due to disturbance of habitats in proximity to turbines and fragmentation of habitat for wide ranging species.

There is limited information upon which to base decisions in regard to wind energy development and wildlife. Most research conducted in association with wind development is short-term and with little follow-up to determine if predictions from research are accurate. Baseline or systematically collected data against which to compare studies of particular sites proposed for development is lacking. More consistent, longer-term pre- and post-construction studies are needed to further elucidate patterns of bird and bat fatality and test hypotheses regarding possible solutions and efficacy of mitigation measures. Use of standardized protocols to address specific questions would greatly improve comparability of studies and credibility of efforts. Consistency across data collection efforts, post-construction evaluations, and access to resulting data are critical for conducting meta-analyses so that statistically significant effects, even if they are small, can be detected.

The magnitude of impacts from wind energy development on wildlife is inconsistently articulated to managers, decision makers, and the public. A lack of transparency related to data collection and inadequate dissemination of findings hinders progress toward developing solutions.

Given the projected increasing development of wind energy, biologically significant cumulative impacts are possible for some species and may become more pronounced over time unless solutions are found. Avoiding, minimizing, and mitigating harmful impacts to wildlife are important elements of "green energy" and it is imperative that developers of wind energy, scientists, and natural resource agency specialists cooperate in developing and testing methods to minimize harm to wildlife.

The policy of The Wildlife Society, in regard to wind energy development is to:

1. Encourage greater coordination among states and provinces and their agencies responsible for wildlife and energy development to ensure consistency in permitting requirements, monitoring and research efforts, and acceptable mitigation, especially for migratory wildlife.

2. Encourage development and consistent implementation of guidelines for siting, monitoring, and mitigation strategies among states, provinces, and federal agencies that establish standards for conducting site-specific, scientifically sound and consistent pre- and post-construction evaluations, using comparable methods as much as is feasible, depending on site characteristics.
3. Advocate for the inclusion of guidelines in the permitting process to further strengthen agency participation and implementation of guidelines.
4. Advocate for the avoidance of siting wind facilities in high-risk areas that are determined based on the best science available.
5. Encourage implementation of on- and off-site habitat mitigation to reduce habitat-related impacts.
6. Encourage priority research that is properly designed and conducted to ensure unbiased data collection that meets peer review and legal standards.
7. Encourage more consistent, longer-term studies that utilize standardized protocols to address specific questions and improve comparability of studies and credibility of efforts.
8. Encourage publication of research results.
9. Encourage regional assessments and forecasting of cumulative land-use and impacts from all sources of energy development, and development of regional conservation strategies among industries, agencies, and private landowners to reduce conflicts and increase options for mitigation and conservation.
10. Educate the public and decision-makers about the natural resources implications of different forms of energy production and encourage efforts to conserve energy
11. Advocate that decision-makers address impacts of wind energy development on wildlife when approving wind energy projects.
12. Encourage the establishment of cooperative relationships between states, provinces, and federal agencies and wind energy companies.

Environmental Impact Statement for the

Midwest Wind Energy Multi-Species Habitat Conservation Plan

How Do I Submit Comments?

- **Written Comments:** Complete and submit this form at a public meeting, or mail your comments to the U.S. Fish and Wildlife Service address at the bottom of this page.
- **Electronic Comments:** Submit electronic comments by visiting the Federal eRulemaking Portal: www.regulations.gov. In the search box enter (Docket Number FWS-R3-ES-2015-0033).

Please refer to Docket No. FWS-R3-ES-2015-0033 in all correspondence.

Scoping comments must be postmarked by August 11, 2015 to be considered in the Draft EIS.

Note that there is a bat hibernacula in
Peninsula state park in Door County, WI.

NOTE: Before including your address, phone number, e-mail address, or other personal identifying information, you should be aware that your personal identifying information may be made publicly available at any time.

James E. Krause
NAME: 4154 Veith Ave
ADDRESS: Madison, WI 53704
CITY, STATE, ZIP CODE: 203 584 5270
PHONE: jimkrause123@gmail.com
E-MAIL:

Comments may be submitted today or mailed to:

Regional Director,
Attn: Rick Amidon
U.S. Fish and Wildlife Service,
Ecological Services
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

From: Laurie Werner <sherman.wind.resistance@gmail.com>

Date: July 15, 2015 at 9:25:51 AM CDT

To: <Jeff_gosse@fws.gov>, <rick_amidon@fws.gov>, <jessica_hogrefe@fws.gov>, <Tom_magnuson@fws.gov>, <robert_krska@fws.gov>, <erik_olson@fws.gov>, <laura_ragan@fws.gov>, <Jennifer_szymanski@fws.gov>

Subject: Industrial Wind Turbines and Bats

Good Morning Everyone,

I represent Sheboygan County Communities for Responsible Energy.

The wind energy industry should NOT be allowed to "TAKE," i.e., slaughter bats, bald eagles, and other migratory birds.

Industrial wind turbines are having a negative impact on humans and on our environment. Our generation will rue the day when they look back and see the negative results that wind turbines have caused.

I would like to know what your department is doing to prevent these "takes" by the wind industry and ask that you do everything you can to prevent further slaughter.

Rural Wisconsin, all its inhabitants, including humans, birds and all other animals are under attack from these wind turbines.
What can YOU do stop this?

Laurie and Fred Werner
Core Team Members
Sheboygan County Communities for Responsible Energy
SHERMAN. WIND.RESISTANCE



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

For related information, [Open Docket Folder](#) 

Comment Period Closed

Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0010

Tracking Number: 1jz-8ki1-rq13

Document Information

Date Posted:

Aug 12, 2015

[Show More Details](#) 

Submitter Information

Submitter Name:

Cathy Woollums

Comment

Please see the attached comments of Berkshire Hathaway Energy Company.

Attachments (1)

[Berkshire Hathaway Energy MSHCP NOI Comments](#)

View Attachment:





August 11, 2015

Submitted electronically to www.regulations.gov

Regional Director
Attention: Rick Amidon
Ecological Services
U.S. Fish and Wildlife Service
5600 American Boulevard West, Suite 990, Bloomington, MN 55437-1458

Re: Docket ID No. FWS–R3–ES–2015–0033
Comments of Berkshire Hathaway Energy on Notice of Intent to Prepare a Draft
Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species
Habitat Conservation Plan

To Whom It May Concern:

Berkshire Hathaway Energy is a global energy services provider serving approximately 8.4 million customers worldwide. Berkshire Hathaway Energy's United States business platforms subject to U.S. Fish and Wildlife Service regulation in the proposed action area include MidAmerican Energy Company, an Iowa-based utility providing regulated electric and natural gas service in Iowa, Illinois, Nebraska and South Dakota; and BHE Renewables, LLC, which owns natural gas, wind, geothermal, solar and hydro projects as an independent renewable power producer in New York, Arizona, Texas, California, Illinois and Hawaii. Berkshire Hathaway Energy facilities generate electricity utilizing geothermal, hydroelectric, wind, solar, natural gas, coal and nuclear resources.

By year-end 2015 Berkshire Hathaway Energy, through its MidAmerican Energy Company and BHE Renewables subsidiaries, will own and operate more than 3,500 Megawatts of wind energy in the Plan Area, which encompasses all lands within the political boundary of U.S. Fish and Wildlife Service Region 3. Consequently Berkshire Hathaway Energy possesses an interest in how the Midwest Wind Energy Multi-Species Habitat Conservation plan (MSHCP) is developed and implemented across the Plan Area.

Berkshire Hathaway Energy welcomes the Service's collaborative and regional approach to the development of the MSHCP, as it may result in permitting efficiencies for the Midwest wind industry. To provide developers, owners, and operators the most flexibility to respond to the unique characteristics of an individual or group of wind energy projects, Berkshire Hathaway Energy recommends the Service provide several clarifications in the MSHCP-related documents.

First, the Service should clarify that participation in the MSHCP is voluntary and project proponents may pursue other options for take coverage at their discretion. If a wind energy facility is located within the Covered Lands and does not opt in to the MSHCP, that facility should not be precluded

from otherwise applying for and obtaining an incidental take permit and habitat conservation plan – for a single or multiple facilities, or a single or multiple species –under authorities such as the Endangered Species Act (ESA) or the Bald and Golden Eagle Protection Act (BGEPA). Reasons to pursue individual permits or opt in to the MSHCP may vary based on a number of factors, including project location, the number of Covered Species present or potentially present, the amount of potential mitigation, or the types of conservation measures implemented by a project. Project owners and operators should be afforded the opportunity to evaluate all factors when determining what type of permit may be appropriate for a project or projects.

Second, the Service should make clear that development and implementation of the MSHCP will neither limit its authority and discretion to issue individual permits under the ESA or BGEPA, individually or programmatically, on Covered Lands, nor will it limit the amount of new wind energy development that may occur within the Covered Lands, even if the amount of new development exceeds that predicted over the permit term. This is especially important as the Environmental Protection Agency finalizes the Clean Power Plan, because renewable energy resources such as wind are anticipated to play a key role in achieving the emissions reductions required under that rule.

Finally, the Service should clarify in the MSHCP that it is not required to issue individual permits to wind projects that contain the same terms and conditions that may be included in the MSHCP. Berkshire Hathaway Energy recognizes that take authorization under the MSHCP would be subject to the Plan's mitigation measures. However, the Service's ESA regulations do not require the Service to impose the same mitigation measures identified in the MSHCP to a permit for a project or projects on Covered Lands that opted out of the MSHCP. Impacts posed by wind energy projects will vary across the Covered Lands; prescribing the types of acceptable mitigation required in a permit outside the reach of the MSHCP limits the ability for wind energy project owners and operators to tailor a project's mitigation as appropriate for its predicted impacts.

Berkshire Hathaway Energy appreciates the opportunity to provide these comments to the Service on the MSHCP NOI. Specific questions may be directed to Jennifer McIvor at 712-352-5434 or jmcivor@midamerican.com.

Respectfully submitted,



Cathy S. Woollums
Sr. Vice President, Environmental and
Chief Environmental Counsel
Berkshire Hathaway Energy Company
106 E. Second Street Davenport, IA 52801
Phone: (563) 333-8009
E-mail: cswoollums@berkshirehathawayenergyco.com



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

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Comment Period Closed

Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0008

Tracking Number: 1jz-8khw-dksb

Document Information

Date Posted:

Aug 11, 2015

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Submitter Information

Submitter Name:

Michael Schirmacher

City:

Austin

Country:

United States

State or Province:

TX

ZIP/Postal Code:

78716

Organization Name:

Bat Conservation International

Comment

See attached file(s)

Attachments (1)

[BCI scoping comments MSHCP](#)

View Attachment: 



11 August 2015

Regional Director
Attn: Rick Amidon
U.S. Fish and Wildlife Service
Ecological Services
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

RE: Docket Number FWS-R3-ES-2015-0033

Dear Mr. Amidon

Thank you for the opportunity to provide scoping comments for the U.S. Fish and Wildlife Service's (USFWS), intent to prepare an environmental impact statement (EIS) to evaluate the impacts of several alternatives relating to the proposed issuance of Endangered Species Act (ESA) incidental take authorization under the Midwest Wind Energy Multi-Species Habitat Conservation Plan (MSHCP). Bat Conservation International (BCI) is an international non-profit dedicated to conserving the world's bats and their ecosystems. BCI has been actively engaged on many issues around North America's bat conservation, including impacts from the wind energy industry, white-nose syndrome, and other critical issues. With respect to bats and wind energy issues, BCI is a founding member of the Bats and Wind Energy Cooperative and has extensive experience with bats and wind energy related issues and impact reduction strategies.

The Federal Register announcement states that the USFWS seeks comments in seven categories regarding the MSHCP. Our comments are stratified below, according to those seven topics.

(1) Biological information and relevant data concerning covered species

We encourage the USFWS to perform a thorough review of published and gray literature regarding the proposed covered bat species (Indiana bat [*Myotis sodalis*], northern long-eared bat [*M. septentrionalis*], and the little brown bat [*M. lucifugus*]), particularly related to differences in habitat use, roosting, hibernating patterns, and wind energy impact among these species. Almost all HCPs thus far have dealt with single wind projects and single species (i.e. Indiana bats). We encourage the USFWS to consider differences among these proposed covered species before applying blanket conservation measures, as actions (be they proposed actions or conservation actions) will likely impact the three species in different ways. The differences among species will likely help define the minimum conservation actions needed to promote the survival or

recovery of these species. We do provide some biologically-relative information for each covered species throughout the sections below.

(2) Additional information concerning the range, distribution, population size, and population trends of covered species

We urge the USFWS to evaluate impacts for each bat species beyond the 8 state scope of the MSHCP, as bats have high levels of connectivity across large geographic areas, larger even than the scope of the MSCHP. Vonhof and Russell (2015) highlight that consequences of mortality extend beyond jurisdictions, particularly for panmictic bat species, such as the eastern red bat (*Lasiurus borealis*). For all proposed covered species, population size and mortality need to be assessed in relation to genetic connectivity or else we may fail to properly conserve the population. For little brown bats, Vonhoff et al. (2015) used standard population genetic analyses to understand gene flow and connectivity. The results identify low levels of genetic differentiation across the very broad range of the species, meaning that individuals travel across large distances and exchange genetic information across those same large distances. Further, their results suggest little brown bat populations are panmictic, at least for the eastern portion of their range. We urge that all analyses be conducted at a meaningful biological scale. For little brown bats, that should be at a range-wide level or, at least, east of the Great Plains-Rocky Mountain transition area, rather than just in the proposed MSHCP area. In addition, we request a similar approach to Indiana bats and suggest using the entire range of the species, as recent genetic analysis suggest high connectivity throughout its range as well (M. Vonhof, pers. comm.). At a minimum, impacts to Indiana bats should be analyzed at the recovery unit level, as long as published information supports this as a meaningful biological scale. Similarly, we suggest using the entire range for the northern long-eared bat for a biologically meaningful analysis, unless data are available suggesting differing genetic connectivity across this species range. Only when considering genetic connectivity of a species is it possible to determine impacts to the population and, therefore, impact reduction strategies and mitigation actions that promote the survival or recovery of the proposed covered species.

Within the ranges mentioned above, we urge the USFWS to obtain the latest information on White-nose Syndrome (WNS) mortality and data on current population trends for all proposed covered species and incorporate that data into their analyses. This information will be vital to understanding the potential impact of the proposed actions to current populations.

(3) Direct, indirect, and cumulative impacts that implementation of the proposed covered activities could have on endangered, threatened, and other covered species, and their communities or habitats

We encourage the USFWS to analyze incidents of direct mortality for all species related to wind energy development and operation. To accurately assess impacts and potential conservation actions, information on impacts, impact reduction strategies, and mitigation options should be evaluated independently for all three proposed covered species. As mentioned in topic 2 above, this analysis should be evaluated at a meaningful biological scale, which considers the genetic connectivity of the population and not be limited to the proposed covered area. Species-specific differences in direct mortality related to wind turbines have been documented, although these fatality events may not be representative of estimated impacts without accounting for

detection bias (more details provided below). At least seven Indiana bat (Pruitt and Okajima 2014) and 41 northern long-eared bat fatalities (USFWS 2015) have been reported at wind energy projects. Based on estimates of cumulative impact for bat species across North America, between 2010 and 2011, fatalities of Indiana bat and northern long-eared bat represented <1% of all bat species documented as fatalities at wind energy facilities (Arnett and Baerwald 2013). Conversely, Arnett and Baerwald (2013) reported little brown bat fatalities represented approximately 6% of all documented bat fatalities and ranked 4th among all documented species. In northeast Pennsylvania, Arnett et al. (2010) reported almost 30% of all fatalities were little brown bats, only exceeded by hoary bat fatalities (*Lasiurus cinereus*). This relative high proportion of little brown bat fatalities has also been documented in other areas. At a wind energy facility in Wisconsin, Drake et al. (2012) reported 31% of bat fatalities were little brown bats. In addition, raw bat fatalities documented at turbines with impact reduction strategies implemented also have reported differences among the proposed covered species. Currently, no northern long-eared bat carcasses have been found at turbines that have implemented operational minimization strategies, although this has limited statistical support as rare events can be difficult to detect (see Huso et al. 2014). An Indiana bat has been found at a turbine with a cut-in speed adjustment from 3.5 m/s to 5 m/s (Good et al. 2011). Alternatively, a number of little brown bat fatalities have been observed at turbines with cut-in speed adjustment to 5 m/s (Arnett et al. 2011) and 5.5 m/s (E. Baerwald, pers. comm.). In fall 2012, at Pioneer Wind Energy Facility, five little brown bat fatalities occurred at turbines implementing impact reduction strategies—raised turbine cut-in speed from 3.5 m/s to 6.9 m/s when temperature were greater than 10°C (Arcadis 2013). The authors do not provide enough information to assess if fatalities occurred at turbines with 6.9 m/s cut-in speed adjustment or at normal operating turbines when the temperature was below 10°C. Species-specific differences in bat fatality and potential effectiveness of impact reduction strategies need extensive evaluation by the USFWS in this EIS.

Direct impacts to bat habitat should be analyzed for each proposed covered species. To minimize and potentially avoid direct impacts to individual bats during project construction, USFWS should consider tree removal outside of the maternity season for all proposed covered species. This should be based on best available data for each species and areas to account for differences in reproduction and thereby avoid potentially felling a maternity roost. In Indiana, Whitaker and Hamilton (1998) reported adults and sub-adult Indiana bat mortality when a maternity tree was harvested in early-September. In Ohio, Belwood (2002) reported adult and non-volant young mortality of Indiana bats after a maternity tree was harvested in early-July.

Timing and demographics of bat fatalities also needs to be included in the direct impacts analysis. Spring and summer fatalities of female bats need to be treated as a lost reproduction opportunity for that year. The analysis of direct impacts needs to include fatalities in the spring and summer for all proposed covered species and account for differences in detection bias, including survey effort, and loss of recruitment. Two of the seven Indiana bat fatalities have been reported in the spring and summer, a female in mid-April and a male in early-July (Pruitt and Okajima 2014). For northern long-eared bat fatalities with associated temporal information, 27% (10 of 36) were documented May–July, although demographics of these fatalities were not provided (S. Hicks, pers. comm.). In addition, Gruver and Schirmacher (2014) summarized documented *Myotis* fatalities and reported 36.5% occurred in spring and summer. They also reported that 44% (544 of 1233) of those documented *Myotis* fatalities did not have associated

temporal data, suggesting our understanding of temporal risk to *Myotis* could be improved. Again these fatality events are not corrected for detection bias, including survey effort, and are only intended to support the need for further analysis on the seasonal risk and potential loss in recruitment for each proposed covered bat species by the USFWS in this EIS.

Indirect effects of wind energy development are less well known for bats than direct mortality; nevertheless, these impacts should be identified and analyzed, including impacts to reproductive output from habitat loss and habitat fragmentation. In Ohio, Belwood (2002) reported that, after a maternity roost was harvested, only a proportion of a colony, approximately 22%, remained in the area that year and that the maternity area was completely abandoned for three years following the loss of the roost tree. Surveys in the fourth year documented 2 female Indiana bats present in that maternity area. USFWS analysis should attempt to identify maternity areas for all proposed covered bat species, and consider the indirect effects associated with wind energy development.

Habitat fragmentation due to wind energy facility construction should also be analyzed as an indirect impact, with the potential to provide siting recommendations as a conservation action. For some bat species, fragmentation might be beneficial (see Gorreson and Willig 2004), but for forest interior species, such as Indiana bats, fragmented environments might increase the chance of bats having to commute longer distances or across less favorable habitat. In Ohio, Kniewski and Gehrt (2014) speculated that Indiana bats had to cross large agricultural areas to reach woodlots. This behavior in fragmented environments could increase collision risk to forest interior species if wind energy development is sited near or between selected habitats for the proposed covered bat species. In addition, large fragmented areas could impact fitness or reproductive success by increasing the energy cost of commuting to selected habitats. This analysis should incorporate other land use practices, such as agriculture and urban development, which could increase fragmentation. Temporal changes in use of migration or commuting corridors, such as migration from summer maternity areas to swarming or hibernation sites, also should be analyzed. Avoidance strategies are likely a better conservation action, and potentially less costly, than impact reduction strategies implemented after construction.

When analyzing cumulative impacts, we encourage the USFWS to obtain and analyze the latest information on wind turbine related fatalities across the entire range, or at least the ranges of high genetic connectivity, for the proposed covered bat species. To accurately assess the cumulative impact of wind turbines on the covered species, raw fatalities need to account for detection bias (e.g. search efficiency, carcass persistence, unsearchable area) to determine the current impact (see Huso 2011, Huso and Dalthrop 2014a). This analysis might require additional datasets from wind energy operators to ensure a representative sample of the cumulative impact to the covered species. As mentioned by Huso and Dalthrop (2014b), current calculations of cumulative impacts are likely based on convenient samples rather than representative samples; therefore, only by increasing our sample size to include the greatest amount of fatality data possible, can we truly estimate bat fatalities from wind energy developments. In addition, these calculations would need to be based on wind energy development/operation and other proposed activities (e.g. Forestry, Oil, Gas, Urban Development, Transportation, etc.) across the species ranges.

We also urge the USFWS to evaluate the potential expansion of wind energy development and any future potential changes in turbine technology (e.g. turbine height, operation, turbine design) within and outside the planned area, given that the ranges of these species do not match the jurisdiction of the proposed covered area. From sites across the U.S. and Canada, there is some suggestion that taller turbines are associated with higher bat fatality rates (Barclay et al. 2007). The USFWS should request and include in the analysis any anticipated changes to turbine technology and potential effects on bat fatality based on best available data.

(4) Other possible alternatives to the proposed action that the Service should consider

Given the scope and scale of the MSHCP, adaptive management will be a key component of its success. We request the USFWS to clearly identify and define adaptive management triggers, the methodology to determine when those triggers have been reached, and the management actions that occur based on those triggers. Those seeking inclusion in this HCP should be required to conduct post-construction monitoring protocols that also account for difficulties of detecting rare events (see Huso et al. 2014). Monitoring must follow an established protocol throughout the plan area; this would allow us to identify and target conservation actions effectively. These methodologies should be informed through robust scientific monitoring protocols, similar to the USFWS Wind Energy Guidelines.

We agree with the exclusion of known sensitive areas for proposed covered species. For bats, we agree that hibernacula should be buffered and excluded from wind energy development. However, we are concerned that the currently proposed excluded areas around hibernacula relies too heavily on known Indiana bat hibernation sites and does not include known hibernation sites for the other two proposed bat species. We request an alternative analysis that is specific to each species, which excludes or limits development near potentially important bat areas. Potentially important bat areas would include any hibernacula with the presence of one or more of the proposed covered species. Presence of any proposed covered bat species would address the uncertainty around priority status of those sites post-WNS. Protecting subterranean environments is vital to the conservation of bats species impacted by WNS, but this is only one aspect of a bat's life cycle. We ask the USFWS to expand excluded areas or limit wind energy development to areas of known high use (e.g. summer maternity areas, swarming sites) or between high use areas (e.g. migratory or commuting corridors). Avoidance of high risk areas would benefit bats, and wind energy operators by limiting conservation action needed to minimize and mitigate impacts to the covered bat species once wind turbines are operational.

Given that the proposed action is to occur over a large area, rather than at an individual project scale, and during a 45 year period, we request the USFWS include in the impacts analysis for take calculations of maximum sustainable yield for each covered species. Maximum sustainable yield (MSY) is a value that is calculated for a variety of wildlife species at the individual population level and is intrinsic to wildlife population ecology. MSY modelling can identify a maximum removal from the population and a needed replacement rate and can identify a level of take that may cause a population decline. This could be modeled with post-WNS population estimates and published data on reproductive rates and used to ensure that the

incidental take authorizations under this MSHCP do not impact the survival of each proposed covered bat species.

We support excluding gray bats (*M. griscesens*) in the MSHCP. We feel the lack of documented fatalities for this species is as likely related to the lack of publically available studies and/or limited wind energy development within this species' range as it is to fatality risk. More information is needed on this species before its inclusion into a programmatic HCP. We urge the USFWS to limit development within the range of this species, however, until risk and impact can be adequately assessed.

(5) Other current or planned activities in the subject area and their possible impacts on covered species

We request the USFWS analyze impacts from all possible development sources across the range, or at least those areas identified with high genetic connectivity, of each proposed covered species by including projected wind energy development and other development over a 45 year period. This should include but not be limited to forestry, oil, gas, residential and urban development, transportation, and energy transmission. Only by including all stresses on bats can we accurately assess the cumulative impact and therefore, minimization and mitigation needed to conserve these species.

(6) The presence of archaeological sites, buildings and structures, historic events, sacred and traditional areas, and other historic preservation concerns, which are required to be considered in project planning by the National Historic Preservation Act

We have no comments or data to provide on this section.

(7) Identification of any other environmental issues that should be considered with regard to the proposed multi-species HCP and permit action

Direct impact of WNS has been well documented but indirect impacts to bats is relatively unknown and should also be evaluated. Recovery of proposed covered species might be slowed due to a number of factors, some of which might not be understood in the short-term. As mentioned above, exclusion or limited development in potentially important areas would give researchers time to better understand any potential changes post-WNS including individual bat behavior, reproductive success, range changes, winter and summer habitat selection, and migration and hibernation changes.

Impacts of climate change need to be considered when assessing the potential impacts to the proposed covered species. Adams (2010) showed that impacts of climate change, such as water loss, will likely impact reproductive success of bat species. A similar analysis should be done in the range of the covered species to accurately assess cumulative impacts to these species.

As mentioned above, pronounced ecological differences and differences in wind energy impacts between little brown bats and the relatively more similar northern long-eared bats and

Indiana bat, need further analysis. We feel that conservation actions, particularly turbine operational changes, for little brown bats would likely benefit northern long-eared bat and Indiana bat, but this would need to be confirmed with further analysis in the EIS. Furthermore, if the little brown bat is included for analysis, as proposed, an alternative analysis that includes the tri-colored bat (*Perimyotis subflavus*), which is experiencing similar impacts by wind energy and WNS, should also be considered.

Thank you for your time and consideration on this issue. BCI recognizes that the scale and scope of the proposed action is unprecedented in its potential impacts to bats and their habitats. We are eager to play an active role in the development of this EIS and offer our assistance to the USFWS, as needed. Please feel free to contact me regarding ways we can provide specialized expertise, or for clarification on any of our comments.

Sincerely,

Andrew Walker
Executive Director

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Senior Director, US/Canada Conservation

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Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

For related information, [Open Docket Folder](#) 

Comment Period Closed

Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0009

Tracking Number: 1jz-8khx-e0k2

Document Information

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Comment

Please see the attached comments, submitted on behalf of the American Bird Conservancy and the Conservation Law Center.

Attachments (1)

[ABC_CLC Comments
\(FWS_R3_ES_2015_0033\)](#)

View Attachment:





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August 11, 2015

Via Federal eRulemaking Portal

Regional Director, Attn: Rick Amidon
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**Re: Draft Environmental Impact Statement for the Proposed Midwest Wind
Energy Multi-Species Habitat Conservation Plan (FWS-R3-ES-2015-0033)**

Dear Mr. Amidon,

On behalf of the American Bird Conservancy and the Conservation Law Center, we appreciate the opportunity to comment on the potential issuance of multiple incidental take permits ("ITP") in connection with the Midwest Wind Energy Multi-Species Habitat Conservation Plan ("MSHCP"). While we applaud the U.S. Fish and Wildlife Service's ("FWS") commitment to renewable energy, we are very concerned that the MSHCP and associated ITPs will significantly imperil birds, bats, and other wildlife. We ask you to consider the comments below in designing and conducting an environmental review that properly assesses the current status of local and migratory species, and carefully analyzes alternatives likely to reduce and eliminate harm. To avoid redundancy, we incorporate by reference our previously submitted comments concerning the draft MSHCP,¹ and reiterate the concerns and recommendations expressed therein.

**I. To Avoid Unnecessary and Illegal Harm to Wildlife, FWS Must
Complete a Thorough Baseline Analysis.**

Pursuant to the National Environment Policy Act ("NEPA"), 42 U.S.C. §§ 4321 *et seq.*, FWS must "describe the environment of the areas to be affected" by ITP issuance.² As the U.S. Court of Appeals for the Ninth Circuit has explained, this analysis of existing conditions is essential "to determine what effect the [action] will have on the

¹ See Attachment A: Jeffrey B. Hyman et al., *Comments on Draft Midwest Wind Energy Multi-Species Habitat Conservation Plan Within Eight-State Planning Area* (Dec. 3, 2013).

² 40 C.F.R. § 1502.15; see also *W. Watersheds Project v. BLM*, 552 F. Supp. 2d 1113, 1126 (D. Nev. 2008) ("In analyzing the affected environment, NEPA requires the agency to set forth the baseline conditions.").

environment, and consequently, ... to comply with NEPA.”³ In the present situation, recent research further emphasizes the importance of understanding wildlife behavior before permitting the expansion of wind energy facilities.⁴ For example, evidence indicates that wind farm development can precipitate the abandonment of otherwise suitable habitat in the region, and lead to substantial shifts in avian community structure.⁵ Indeed, experts warn that “[a] major reason for the inadequacy and uncertainty in our understanding of the impact of turbines on birds is that complete population[s] and not just individuals living in the close vicinity of turbines need to be monitored before and after the installation of a wind power plant.”⁶ Accordingly, we urge FWS to fulfill its duty to complete a thorough baseline analysis.

II. In Light of Significant Scientific Uncertainty, FWS Must Consider a Shorter Permit Term and a Smaller Project Area.

According to a recent Federal Register publication,⁷ FWS estimates that ITP issuance will help to increase Midwestern wind energy production by over 240 percent during the 45-year permit term. Although this ambitious plan incorporates industry interests, the scale of anticipated development fails to account for widespread scientific uncertainty regarding the environmental effects of wind energy operations. For example, while experts agree that existing data underestimate harm to wildlife,⁸ there is

³ *Half Moon Bay Fisherman’s Mftg. Ass’n v. Carlucci*, 857 F.2d 505, 510 (9th Cir. 1988); see also *N. Plains Res. Council v. Surface Transp. Bd.*, 668 F.3d 1067, 1085 (9th Cir. 2011) (“[W]ithout [baseline] data, an agency cannot carefully consider information about significant environmental impacts. Thus, the agency fail[s] to consider an important aspect of the problem, resulting in an arbitrary and capricious decision.”).

⁴ See, e.g., Attachment B: Kaoshan Dai et al., *Environmental Issues Associated with Wind Energy – A Review*, 75 RENEWABLE ENERGY 911, 912 (2015) (explaining that developers “should work with ornithologists” to “record[]”, “analyze[]”, and “stud[y] systematically” wildlife communities and activities in the vicinity of a planned wind farm); see also Attachment C: M. Premalatha Tabassum-Abbasi et al., *Wind Energy: Increasing Deployment, Rising Environmental Concerns*, 31 RENEWABLE AND SUSTAINABLE ENERGY REV. 270, 277 (2014) (warning that “conclusions of low-impact drawn from some studies cannot be extrapolated to other locations,” because “detailed site-specific assessments are necessary”).

⁵ See Tabassum-Abbasi et al., *supra* note 4, at 277.

⁶ *Id.* at 278.

⁷ Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan, 80 Fed. Reg. 33,537, 33,539 (June 12, 2015).

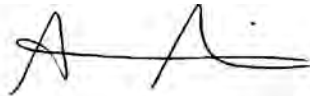
⁸ See, e.g., Attachment D: Shifeng Wang et al., *Impacts of Wind Energy on Environment: A Review*, 49 RENEWABLE AND SUSTAINABLE ENERGY REV. 437, 439 (2015) (explaining that bird and bat fatality measurements must “be adjusted upwards”); see also Dai et al., *supra* note 4, at 912 (“The accurate bird fatality rate is difficult to estimate due to variations in search area, searcher efficiency and predator removal rates.”); Tabassum-

currently no consensus with respect to the calculation of risk.⁹ Because environmental effects and management techniques vary with geographic location,¹⁰ we urge FWS to consider a smaller project area. We also recommend that the agency impose a shorter permit term to allow for the incorporation of emerging scientific data and rapidly developing technology.¹¹

III. Conclusion

Recent scientific evidence confirms that wind energy facilities pose a serious risk to birds, bats, and other wildlife. As these brief comments and those incorporated by reference explain, careful analysis and development is necessary to prevent unnecessary and illegal harm. We urge FWS to conduct a thorough environmental analysis and proceed with caution to ensure that the expansion of renewable energy does not compromise wildlife conservation.

Sincerely,



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Abbasi et al., *supra* note 4, at 284 (acknowledging that “the adverse impacts of wind power plants on wildlife, especially birds and bats, are likely to be much greater than is reflected in the hitherto reported figures of individuals killed per turbine.”).

⁹ See, e.g., Wang et al., *supra* note 8, at 439 (identifying various risk factors for wildlife, but acknowledging that the relationship between these factors and fatalities “is still unclear”); see also Dai et al., *supra* note 4, at 912 (“Although there are many studies, the correlation between wind turbine induced bird mortality and many other variables such as turbine types and topographic features have not yet been established.”); Attachment E: Ana Teresa Marques et al., *Understanding Bird Collisions at Wind Farms: An Updated Review on the Causes and Possible Mitigation Strategies*, 179 BIOLOGICAL CONSERVATION 40, 41 (2014) (“[I]nformation on the causes of bird collisions with [wind turbines] remains sparse.”).

¹⁰ See, e.g., Wang et al., *supra* note 8, at 439, 440 (explaining that bird and bat mortality “are very dependent on the ... specific site [and] topography,” among other factors).

¹¹ See Marques et al., *supra* note 9, at 48 (explaining that new automated tools to monitor bird activity near wind farms are “under development” and “likely ... will be available in the future”).



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ATTACHMENT A:

Jeffrey B. Hyman et al., *Comments on Draft Midwest Wind Energy Multi-Species Habitat Conservation Plan Within Eight-State Planning Area* (Dec. 3, 2013)



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December 3, 2012

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E-Mail: midwestwindhcp@fws.gov

**Subject: Comments on Draft Midwest Wind Energy Multi-Species Habitat
Conservation Plan Within Eight-State Planning Area**

Sent via E-mail (receipt verification requested)

Dear Mr. Amidon:

Please find below our timely submitted comments on the U.S. Fish and Wildlife Service's notice of intent and request for comments pertaining to the Draft Midwest Wind Energy Multi-Species Habitat Conservation Plan Within Eight-State Planning Area [FWS-R3-ES-2012-N225; FXES11120300000F2-123-FF03E000000].¹ The deadline for comments on this notice and request is December 3, 2012.

Thank you for this opportunity to comment. These comments are jointly submitted by the Conservation Law Center and the American Bird Conservancy. The Conservation Law Center ("CLC") is a not-for-profit public interest law firm located in Bloomington, Indiana, and operates the Conservation Law Clinic under an agreement with Indiana University Maurer School of Law. The CLC represents non-profit environmental organizations and governmental entities in conservation matters and works to improve conservation law and policy. American Bird Conservancy ("ABC") is a not-for-profit membership organization whose mission is to conserve native birds and their habitats throughout the Americas. ABC acts across the full spectrum of threats to birds to safeguard the rarest bird species, restore habitats, and reduce threats, unifying and strengthening the bird conservation movement.

¹ The original Federal Register notice coordinates were FWS-R3-ES-2012-N179; FXES11120300000F2-123-FF03E000000. See 77 Fed. Reg. 52754 (*Draft Midwest Wind Energy Multi-Species Habitat Conservation Plan Within Eight-State Planning Area*) (Aug. 30, 2012).



Wind power is one of the fastest developing sources of energy in the United States and could be an important part of the solution to climate change. However, wind farms can kill wildlife through collisions with turbines and associated structures. Wind farms can also harm wildlife by displacing species from habitat needed for survival, as well as by destroying, degrading, or fragmenting habitat. The CLC and ABC believe that wildlife and wind power can co-exist if wind projects are carefully designed, sited, studied, operated, monitored, and mitigated. Of these principles, careful siting is the most important.

We divide our comments below into six parts. In Part I we comment on species that should be covered and protected under the Midwest Wind Energy Multi-Species Habitat Conservation Plan (“MSHCP”). Part II discusses areas in the eight-state planning region that should be excluded from permitted wind development. In Part III we comment on avoidance and minimization measures for the proposed MSHCP. Part IV discusses the need for a clear and well-defined adaptive management scheme. Part V focuses on the permitting structures proposed for the MSHCP/ITP(s) and the need for second-tier siting analysis. In Part VI, we comment on planning the direct, indirect, and cumulative effects analysis for the MSHCP to assist the U.S. Fish and Wildlife Service (“USFWS”) with its Section 7 jeopardy assessment under the Endangered Species Act (“ESA”).

PART I: PROTECTION FOR SPECIES

COMMENT I.1. **Besides the Eight Proposed Listed and Candidate Species, the MSHCP Should Cover Several Additional Listed, Candidate, and Non-Listed Species.**

A. **Background to Comment.**

The MSHCP planning partners are proposing to cover eight ESA-listed or ESA-candidate species: the endangered Indiana Bat (*Myotis sodalis*), the endangered Gray Bat (*Myotis grisescens*), the endangered Piping Plover (*Charadrius melodus*), the endangered Interior Least Tern (*Sterna antillarum athalassos*), the endangered Kirtland's Warbler (*Setophaga kirtlandii*), the Little Brown Bat (*Myotis lucifugus*), the Northern-Long Eared Bat (*Myotis septentrionalis*), and the Eastern Small-Footed Bat (*Myotis leibii*). The Bald Eagle (*Haliaeetus leucocephalus*) is also being considered for inclusion but no decision has yet been made.

The original grant proposal for the MSHCP, submitted by Indiana, Ohio, Michigan, Missouri, and Iowa in 2009, planned to include 30 species, from bats and birds to mollusks and fish.² These species were identified by comparing high potential wind development areas with information on the presence/absence of federally listed or candidate species in the Midwest region.³ This shows that, at least initially, the states anticipated that the MSHCP would protect a range of species against a number of threats. The Federal Register notice does not provide an explanation for the reduction in the number of proposed covered species, and we urge the planning partners to incorporate additional ESA-related species (endangered, threatened, or candidate) into the MSHCP as well as additional bird species that are most susceptible to becoming listed in the near future.

² Grant Proposal, *Development of a Multi-Species Habitat Conservation Plan for Wind Energy Development in the Midwest*, Table 1, available at <http://www.fws.gov/midwest/endangered/grants/2010/pdf/MultiStateWindHCPproposal.pdf>.

³ *Id.* at p. 4. High potential wind development areas in the Midwest region are those with average wind speeds of 7 meters per second or greater at 50 meters in height. *Id.*

B. The MSHCP Should Cover All ESA-Listed Species that Occur or May Occur in the Eight-State Planning Region.

The USFWS HCP Handbook advises permit applicants “to include all federally listed wildlife species likely to be incidentally taken during the life of the project or permit.”⁴ If take of ESA-listed species not covered by the MSHCP/ITP(s) occurs, the wind companies can be liable for violating the ESA and “project activities could be stopped or delayed after the permit has been issued.”⁵ Even prior to any take, if take of any of these species appears imminent, the wind companies can be enjoined from moving forward with construction and operation of their wind facilities.⁶

To avoid such a result, the MSHCP should cover all ESA-listed species (endangered or threatened) that currently use the plan area or that may occur anywhere within the proposed plan area over the term of the MSHCP. The Ozark Big-Eared Bat (*Corynorhinus townsendii ingens*), for example, is a federally listed endangered species and is known to or is believed to occur in Missouri.⁷ Unless it is covered under the proposed MSHCP, any take of this species is prohibited and wind facilities can be held liable.

C. The MSHCP Should Cover All ESA Candidate Species that Occur or May Occur in the Eight-State Planning Region.

USFWS strongly encourages applicants to include candidate species in HCPs as well as non-listed species having the potential to become listed during the life of the HCP.⁸ All candidate species that currently use the MSHCP plan area or that may expand their distribution into the plan area should be included as covered species in the MSHCP.

In particular, USFWS and its planning partners should cover Sprague’s Pipit (*Anthus spragueii*). Sprague’s Pipit is an ESA candidate species and a Midwest Bird of Conservation

⁴ USFWS, *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (Nov. 1996), at p. 3-7 (emphasis in original) [hereinafter “HCP/ITP Handbook”].

⁵ USFWS, *HCP/ITP Handbook*, at p. 3-7.

⁶ See, e.g., *Animal Welfare Institute v. Beech Ridge*, 675 F.Supp.2d 540 (D. Md. 2009).

⁷ USFWS, *Species Profile for the Ozark Big-Eared Bat*, <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A075>; see also USFWS Midwest Region, *Missouri: Federally-Listed Threatened, Endangered and Candidate Species County Distribution*, <http://www.fws.gov/midwest/endangered/lists/missouri-spp.html>.

⁸ USFWS, *HCP/ITP Handbook*, Chapt. 4. The Handbook identifies two main reasons for including unlisted species in an HCP: “(1) to provide more planning certainty to the permittee in the face of future species listings; and (2) to increase the biological value of HCPs through comprehensive multi-species or ecosystem planning that provides early, proactive consideration of the needs of unlisted species.” *Id.* at 4-1.

Concern.⁹ Its current range includes northeastern Minnesota,¹⁰ though there have been sightings in Michigan and Ohio, which were part of the Pipit's historic range.¹¹ Once common, their numbers have now declined drastically.¹² Sprague's Pipit is one of the few species endemic to the North American grasslands. Like many grassland species, Sprague's Pipits are semi-nomadic, seeking suitable grassland conditions within their range for nesting in any particular year. Sprague's Pipits require unbroken tracts of native grassland and have high altitude aerial displays. They would clearly be at risk of colliding with wind turbines, and wind farms might cause abandonment of otherwise suitable habitat.

Sprague's Pipit is at special risk for take by collisions with wind turbines because its behavior includes the longest periods of aerial display of any passerine species, and its display heights place the Pipit within the rotor-swept zone of modern wind turbines. Aerial display times may be as long as three hours by a single Pipit, and display heights of 50 to more than 100 meters above the ground have been documented.¹³ In addition, the Government of Alberta's Wildlife Guidelines for Alberta Wind Energy Projects identify Sprague's Pipit as a species with potential for collisions with wind turbines due to its aerial display.¹⁴

D. The MSHCP Should Cover Additional Bird Species that Occur in the Eight-State Planning Region and Are Most At Risk of Becoming Listed Under the ESA.

ABC recently published a comprehensive study on the conservation status of American bird species and sub-species.¹⁵ Using a range of factors, the study ranked species into four categories in order of increasing risk: Secure, Potential Concern, Vulnerable, and At-Risk. The

⁹ See USFWS, *Species Profile for Sprague's Pipit*, <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0GD>; USFWS News Release, *Listing of Sprague's Pipit Under ESA Found Warranted But Precluded* (Sept. 14, 2010), available at <http://www.fws.gov/mountain-prairie/pressrel/10-61.htm>.

¹⁰ See USFWS, *Species Profile for Sprague's Pipit*, <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0GD>.

¹¹ See 74 Fed. Reg. 63337 (90-Day Finding on a Petition to List Sprague's Pipit as Threatened or Endangered), available at <http://www.gpo.gov/fdsys/pkg/FR-2009-12-03/html/E9-28868.htm>. Michigan and Ohio were part of the Pipit's historic range. See USFWS, *Region 3 Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/candidat.html>.

¹² See USFWS, *Region 3 Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/candidat.html>.

¹³ Mark B Robbins, "Display Behavior of Male Sprague's Pipits," 110 *Wilson Bulletin of Ornithology* 435 (1998).

¹⁴ Government of Alberta, *Wildlife Guidelines for Wind Energy Projects* (Sept. 2011), at p. 3, available at <http://srd.alberta.ca/FishWildlife/WildlifeLandUseGuidelines/documents/WildlifeGuidelines-AlbertaWindEnergyProjects-Sep19-2011.pdf>.

¹⁵ American Bird Conservancy, *List of the Birds of the United States with Conservation Rankings* (2012) <http://www.abcbirds.org/abcprograms/science/conservationchecklist/index.html>.

MSHCP planning partners should cover the bird species that occur in the planning area and are identified in the ABC study as “At-Risk.”¹⁶ These are species that need immediate conservation attention if they are to survive the range of environmental challenges they face, such as habitat loss, global warming, and invasive species.

The following “At-Risk” species are not currently listed under the ESA and stand to gain significantly from conservation measures targeting their habitat needs under a MSHCP. If they are not incorporated into the MSHCP and do not receive those habitat benefits, these species are more likely to become endangered over the next 30 years:

- Yellow Rail
- Black Rail
- Buff-breasted Sandpiper
- Golden-winged Warbler (currently under USFWS review for listing under the ESA)¹⁷

E. Bald Eagles Should Be a Covered Species Given Their Presence in the Eight-State Planning Region.

The Bald and Golden Eagle Protection Act (“BGEPA”) prohibits the unpermitted take of Bald and Golden Eagles.¹⁸ The BGEPA defines “take” broadly to include, among other activities, the wounding, killing, or disturbing of Bald and Golden Eagles or their nests.¹⁹ The prohibitions of the BGEPA extend to activities that result in the unintentional or incidental take of Bald and Golden Eagles, and when the recurring take of Bald and Golden Eagles is associated with but is not the purpose of a given project or activity, the proponent of the project or activity must obtain a programmatic permit from USFWS to avoid liability for take.²⁰

The 2009 Eagle Permit Take Rule defines a programmatic take as one that is “recurring, but not caused solely by indirect effects, and...occurs over the long term and/or in a location or locations that cannot be specifically identified.”²¹ The programmatic permit strategy is “designed to provide a net benefit to eagles by reducing ongoing unauthorized take.”²² USFWS

¹⁶ American Bird Conservancy, *At-Risk Birds – Lists and Charts*, available at <http://www.abcbirds.org/abcpprograms/science/conservationchecklist/charts.html>.

¹⁷ See USFWS, *Species Profile for the Golden-Winged Warbler*, <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0G4>.

¹⁸ 16 U.S.C. § 668.

¹⁹ 16 U.S.C. § 668c.

²⁰ 50 C.F.R. § 22.26.

²¹ 74 Fed. Reg. 46836, 46841 (*Eagle Permits; Take Necessary To Protect Interests in Particular Localities*) (Sept. 11, 2009).

²² 74 Fed. Reg. at 46842.

regulations implementing the BGEPA allow the Service to issue programmatic eagle take permits only when the direct and indirect effects of the take and required mitigation, together with the cumulative effects of other permitted take, are compatible with the “preservation” of Bald and Golden Eagles, the permitted take is “unavoidable,” and the taking will occur “despite application of advanced conservation practices.”²³ In short, if the proponent of a project that is likely to take Bald or Golden Eagles fails to obtain a programmatic eagle take permit, then that project proceeds in violation of the BGEPA.

Project developers may seek to include Bald and Golden Eagles as covered species under an ESA Section 10 ITP.²⁴ To do so, the HCP must meet BGEPA permit issuance criteria. A Section 10 ITP can be issued only if it is otherwise lawful, meaning here that the ITP will not cause the unauthorized take of Bald or Golden Eagles. Hence, if the HCP does not meet BGEPA permit issuance criteria, the ITP would be unlawful because it would cause the unauthorized take of Bald or Golden Eagles.²⁵ Similarly, if the HCP seeks to cover Bald or Golden Eagles as non-listed species but BGEPA mitigation and minimization requirements are not met, the ITP cannot be issued, given that the “permitted activity [would be] incompatible with the preservation of the bald or golden eagle.”²⁶

We support including the Bald Eagle as a covered species under the MSHCP. We discuss the Golden Eagle below in Comment I.2.C. The National Bald Eagle Management Guidelines state that significant Bald Eagle populations occur in the Great Lakes states.²⁷ Although delisted in 2007, the Bald Eagle remains a Bird of Conservation Concern and FWS continues to monitor the species’ progress post-delisting. The expanding wind energy sector presents serious risks to Bald Eagles. A 2004 Bald Eagle assessment by the U.S. Bureau of Land Management states that “an increase in the number and type of wind-power turbines will generally increase the number of Bald Eagle deaths by aerial collisions, especially if such turbines are positioned with little consideration of Bald Eagle habitat.”²⁸ Bald Eagle deaths at

²³ 74 Fed. Reg. at 46842.

²⁴ See USFWS, *Draft Eagle Conservation Plan Guidance* (Jan. 2011), at p. 9.

²⁵ USFWS, *Draft Eagle Conservation Plan Guidance* (Jan. 2011), at p. 9.

²⁶ 50 C.F.R. § 22.11.

²⁷ USFWS, *National Bald Eagle Management Guidelines* (2007), at p. 3.

²⁸ Amber Travsky & Gary P. Beauvais, *Species Assessment for Bald Eagle (*Haliaeetus Leucocephalus*) in Wyoming* (prepared for BLM, 2004).

wind energy facilities in the United States appear to be increasing and have occurred at facilities as small as a single 10 kW wind turbine.²⁹

COMMENT I.2. In Addition to Covered Species, the MSHCP Should Incorporate a Second Tier of Protection for Bird Species Vulnerable to Threats from Development.

A. Background to Comment.

The list of species currently proposed for coverage suggests that the planning partners are focusing on bird and bat species that occur widely in the eight-state planning region, are most susceptible to collision with wind turbines and associated facility infrastructure, and with the exceptions of the Bald Eagle and the Little Brown Bat, are already listed as endangered species or are pending review under the ESA. Although collision risk may be the most visible threat to wildlife, wind development has other important repercussions on habitat, breeding, and migratory movement. Many species are vulnerable to habitat disturbance, degradation, and fragmentation and may be equally harmed by those threats as by collision.

The MSHCP should adopt a two-tiered approach to protecting species. As discussed above in Comment I.1., the MSHCP should fully cover all ESA-related species (endangered, threatened, and candidate) that occur in the eight-state planning region, the Bald Eagle, and bird species that are most at risk of becoming listed under the ESA. A second tier of protection should be developed for bird species that are less at risk of being listed – and therefore are not proposed as “covered species” – but that would benefit significantly from siting restrictions and operational measures specific to the individual species.

B. Bird Species Identified as “Vulnerable” in ABC’s Conservation Checklist Merit Protective Measures Under the MSHCP.

The Migratory Bird Treaty Act (“MBTA”) prohibits the unpermitted take of listed migratory birds, whether done intentionally or occurring incidentally to an otherwise lawful activity.³⁰ The regulations implementing the MBTA define “take” broadly to include, among

²⁹ See, e.g., USFWS, *Eagle’s Cause of Death Confirmed at Eastern Neck National Wildlife Refuge in Maryland* (undated), available at

<http://www.fws.gov/northeast/ecologicalservices/pdf/EasternNeckeaglestrikeatturbine7312.pdf>.

³⁰ 16 U.S.C. §§ 703, 707.

other activities, the wounding and killing of migratory birds.³¹ In addition, Executive Order 13186 directs federal agencies and executive departments to promote the conservation of migratory birds protected by the MBTA, including the identification and minimization of incidental or unintentional take of migratory birds that is reasonably attributable to agency actions.³²

The MSHCP should develop measures to avoid take of individuals from sensitive bird species vulnerable to habitat loss and collision. Examples of protective measures include avoiding important habitat like breeding/nesting grounds and curtailing/feathering turbines upon observation of a bird of a particular species. It may also be possible to include habitat acquisition or restoration for these birds in the MSHCP's proposed "green infrastructure" mitigation approach, especially for those species that have similar habitat needs to the covered species.

Specifically, the USFWS Midwest Birds of Concern³³ that are designated as Rare or Declining and that have been identified as Vulnerable in ABC's Conservation Checklist³⁴ should be afforded protection under the MSHCP. Birds of these species need conservation attention because they have limited habitat ranges, live in smaller populations, face significant threats, or are experiencing negative population trends. The needs of these species, given their low population numbers and declining trends, should be given adequate consideration under the MSHCP. Under the MBTA and Executive Order 13186, USFWS has a duty to protect these species and a responsibility to prevent their take from threats such as wind energy development. In addition, because these are USFWS-designated Birds of Conservation Concern,³⁵ including protections for them in the MSCHP will help USFWS fulfill a major objective of the Birds of Conservation Concern list: "Our goal is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions."³⁶ Keeping these birds off the endangered species list will also benefit the wind industry.

³¹ 50 C.F.R. § 10.12.

³² Exec. Order No. 13186 (Jan. 10, 2001).

³³ USFWS, *Migratory Birds: Midwest Birds of Concern*, <http://www.fws.gov/midwest/midwestbird/concern.html>.

³⁴ See American Bird Conservancy, *List of the Birds of the United States with Conservation Rankings*, <http://www.abcbirds.org/abcprograms/science/conservationchecklist/index.html>. ABC's Conservation Checklist utilizes the 2012 Partners in Flight update to species assessment scores.

³⁵ See USFWS, *Birds of Conservation Concern 2008*, Table 41 (USFWS Region 3), at p. 59, available at <http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf>.

³⁶ See USFWS, *Birds of Conservation Concern 2008*, at p. iii, <http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf>.

The following species are “Vulnerable” bird species that should benefit from a second tier of protective measures under the MSHCP:

- Whooping Crane (experimental population) [avoid developing in stopover habitat, curtail turbines on observation of individual in project area]
- Cerulean Warbler [avoid developing in breeding habitat]
- Henslow’s Sparrow [avoid developing in breeding and other important habitat]
- Baird’s Sparrow [avoid developing in breeding habitat]
- Olive-sided Flycatcher [avoid developing in breeding habitat]
- Nelson’s Sparrow [avoid developing in breeding and stopover habitat]
- Marbled Godwit [avoid developing in breeding and general habitat]
- Semipalmated Sandpiper [avoid developing in stopover habitat]
- Red-headed Woodpecker [avoid developing in breeding habitat]
- Wood Thrush [avoid developing in breeding habitat]
- Chestnut-collared Longspur [avoid developing in habitat]
- Blue-winged Warbler [avoid developing in breeding habitat]
- Prairie Warbler [avoid developing in breeding habitat]
- Prothonotary Warbler [avoid developing in breeding habitat]
- Swainson’s Warbler [avoid developing in breeding habitat]
- Kentucky Warbler [avoid developing in breeding habitat]
- Canada Warbler [avoid developing in breeding habitat]

C. The MSHCP Must Incorporate Protective Measures for the Golden Eagle.

USFWS has estimated the U.S. Golden Eagle population at approximately 30,000,³⁷ and 1,000 to 2,500 individuals of that population have been estimated to occur east of the Mississippi River.³⁸ Golden Eagles use a range of habitats including grasslands, tundra, forested habitat, brush lands, deserts, and woodlands. The species is thus exposed to a multitude of threats, and Golden Eagle experts have ranked wind energy as the third greatest mortality threat.³⁹

It is a violation of the BGEPA to kill or disturb a single Golden Eagle without an appropriate permit. Given that the distribution of Golden Eagles includes areas in the eight-state planning area, the MSHCP must incorporate measures that protect against take of Golden Eagles. It is likely that wind turbines in the Midwest Region will take Golden Eagles and thus create a violation of the BGEPA. Under the current eagle permitting structure, however, USFWS cannot provide for the legal programmatic take of Golden Eagles in the eastern United States. The Federal Register notice for the 2009 Eagle Permit Rule specifies that “[f]or golden eagles east of

³⁷ USFWS, *Golden Eagles Status Fact Sheet* (2011).

³⁸ See Todd Katzner, et al. *Status, Biology, and Conservation Priorities for North America’s Eastern Golden Eagle (Aquila Chrysaetos) Population* (2012), *The Auk* 129(1):168–176, at p. 168.

³⁹ See USFWS, *Minutes and Notes from the North American Golden Eagle Science Meeting* (Sept. 21, 2010).

100 degrees West longitude, [the Service] will not issue any take permits unless necessary to alleviate an immediate safety emergency.”⁴⁰ Insufficient information on the rates of Golden Eagle mortality in the eastern U.S. provided the basis for this prohibition.

As a result of this conflict, USFWS must complete an Environmental Assessment (“EA”) or an Environmental Impact Statement (“EIS”) under the National Environmental Policy Act (“NEPA”) if the agency seeks to permit take of Golden Eagles beyond the western U.S. An EA or EIS is necessary to determine the effects of permitting programmatic take of Golden Eagles, and the results of the agency’s analysis will provide a scientific basis for determining whether take of Golden Eagles east of 100 degrees West longitude should or should not be permitted.

Given the current conflict in the BGEPA permitting structure, the MSHCP must incorporate protective measures for Golden Eagles. Proper siting and operational measures should be implemented to avoid take of the species and to avoid development in its breeding habitat. We further discuss siting, design, and operational measures in Parts II and III below.

⁴⁰ 74 Fed. Reg. at 46840.

PART II: NO-DEVELOPMENT ZONES

COMMENT II.1. Designated Critical Habitat Within the Eight-State Planning Region Should Be Excluded from Wind Energy Development, As Should Important Habitat for ESA-Listed Species That Have Not Had Critical Habitat Designated.

All ESA-designated critical habitat in the eight-state planning region should be off-limits to siting of proposed wind projects and should not be eligible for the legal protection granted by an ITP. Critical habitat has been designated in the eight-state region for the following species (by state):

- Illinois: Piping Plover, Hine's Emerald Dragonfly⁴¹
- Indiana: Piping Plover⁴²
- Iowa: Topeka Shiner, Higgins Eye Pearlymussel⁴³
- Michigan: Piping Plover⁴⁴
- Minnesota: Canada Lynx, Piping Plover, Topeka Shiner⁴⁵
- Missouri: Indiana Bat, Niangua Darter, Hine's Emerald Dragonfly, Tumbling Creek Cave Snail⁴⁶
- Ohio: Piping Plover⁴⁷
- Wisconsin: Piping Plover, Hine's Emerald Dragonfly⁴⁸

Kirtland's Warbler is an example of an endangered species that has not had critical habitat designated in the eight-state planning region. Important habitat for it and any other ESA-listed species without designated critical habitat should also be off-limits to siting of proposed wind projects and should not be eligible for the legal protection granted by an ITP.

⁴¹ USFWS Midwest Region, *Illinois: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-il.html>.

⁴² USFWS Midwest Region, *Indiana: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-in.html>.

⁴³ USFWS Midwest Region, *Iowa: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-ia.html>.

⁴⁴ USFWS Midwest Region, *Michigan: Federally-listed Threatened, Endangered, Proposed, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/michigan-spp.html>.

⁴⁵ USFWS Midwest Region, *Minnesota: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-mn.html>.

⁴⁶ USFWS Midwest Region, *Missouri: Federally-Listed Threatened, Endangered and Candidate Species County Distribution*, <http://www.fws.gov/midwest/endangered/lists/missouri-spp.html>.

⁴⁷ USFWS Midwest Region, *Ohio: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-oh.html>.

⁴⁸ USFWS Midwest Region, *Wisconsin: Endangered, Threatened, and Candidate Species*, <http://www.fws.gov/midwest/endangered/lists/state-wi.html>.

COMMENT II.2. Wind Energy Development Should Be Excluded from Areas That Pose High Risk to Birds.

The MSHCP should channel wind development to areas that pose low risk to birds by excluding high risk land from development. USFWS and its planning partners should consult ABC's Wind Development Bird Risk Map ("the Map").⁴⁹ The Map identifies areas in the U.S. that pose elevated risk to birds, based on susceptibility to collision and/or susceptibility to displacement from nesting, foraging, and transit areas.

Areas that pose a high risk and are of critical importance to bird species are shown in red on the Map. These lands include the following: ESA-designated critical habitat, other important habitat for bird species, important bird areas where large numbers of migratory birds congregate, important bird areas that are home to rare birds, and areas where large number of birds are present on a seasonal basis. Wind facility development presents significant threats to birds and their habitat in these environs. Any land labeled by the color red in the eight-state planning region should be a no wind facility development zone. USFWS and its planning partners should also consult Audubon Important Bird Areas for exclusion areas.⁵⁰

COMMENT II.3. The MSHCP Should Channel Wind Development to Lands that Pose the Lowest Risk to Bats by Excluding Development in Areas That Are Home to Important Bat Hibernacula, Habitats, and Aggregations.

Similar to ABC's Wind Risk Map, the MSHCP planning partners should conduct a regional, landscape-level analysis of collision/barotrauma and displacement risks for bat species. Wind development should not be permitted in areas that are home to important bat hibernacula, maternity colonies, or spring or fall swarming aggregations. Major migratory corridors from winter habitat to summer habitat for covered bat species should likewise be excluded from wind development.

⁴⁹ American Bird Conservancy, *Wind Development Bird Risk Map*, available at <http://www.abcbirds.org/extra/windmap.html>.

⁵⁰ See Audubon, *Important Bird Areas Program*, available at <http://web4.audubon.org/bird/iba/>.

COMMENT II.4. Sensitive, Essential, and Exceptional Areas Such As Refuges, Migratory Routes, and Large Blocks of Intact Native Landscapes Should Be Excluded from Wind Energy Development.

USFWS and its planning partners should identify sensitive, essential, and exceptional locations potentially used by one or more of the species covered by the MSHCP and should exclude those areas from the MSHCP's coverage. The following general areas are likely to contain sensitive, essential, or exceptional locations:

- Broad geographic areas of high sensitivity such as those mentioned in the USFWS *Land-Based Wind Energy Guidelines* and The Nature Conservancy's *Great Lakes Regional Guidelines*.
 - large blocks of intact native landscapes and intact ecological communities, especially rare landscape types such as intact grasslands greater than 76 acres in size, forest patches greater than 5,080 acres in size in agricultural or urban landscapes, and prairie or savanna remnants of any size;
 - riparian corridors and lake shorelines;
 - inland wetland complexes and connected upland habitats;
 - known migratory routes and staging areas;
 - fragmentation-sensitive species' habitats;
 - high-priority conservation areas for NGOs;
 - other local, state, regional, federal, tribal, or international categorizations.
- River and forest systems acting as valuable diurnal migration corridors.
 - Maps of "Potential Bird-Structure Collision Areas" for Iowa, Minnesota, and Wisconsin with accompanying descriptions are available at <http://www.fws.gov/midwest/wind/resources/biomaps.html>.
- Sensitive natural resources areas.
 - USFWS provides several maps of biological resources in the Midwest Region, including "Areas of Concern for Wind Farm Sitings" (Iowa), areas with potential species richness, Service lands, staging areas, and bird migration routes. These maps are available at <http://www.fws.gov/midwest/wind/resources/biomaps.html>.
- Wildlife refuges.
 - A list of national wildlife refuges and wetland management districts in the Midwest can be found at <http://www.fws.gov/midwest/Refuges/visit.html>.
 - An overview of conservation planning on the national wildlife refuges in the Midwest Region is available at <http://www.fws.gov/midwest/planning/plansbystate.html>.
- Locations where partnerships with private landowners are being formed to protect habitat where imperiled species are present or where those species could be reintroduced.

- Formation of such partnerships is underway throughout the MSHCP corridor. To learn their locations, we suggest contacting the recovery coordinators for each of the covered species, the Nature Conservancy office for each state in the MSHCP plan area, and each national wildlife refuge in the MSHCP plan area.

COMMENT II.5. “No-Development” Zones Should Be the Basis for Setting the MSHCP’s Boundaries.

The Federal Register notice for the MSHCP states that the planning area encompasses the Midwest Region of the Service but that the specific land covered by the MSHCP has not yet been determined and “could be all or portions of the eight States.” The USFWS’s HCP Handbook encourages applicants “to consider as large and comprehensive a plan area as is feasible and consistent with their land or natural resource use authorities”⁵¹ but notes that boundaries should “be as exact as possible” to “avoid later uncertainty about where the [ITP] applies or where permittees have responsibilities under the HCP.”⁵²

The HCP Handbook also states that “HCP boundaries should encompass *all areas* within the applicant’s project, land use area, or jurisdiction *within which any permit or planned activities likely to result in incidental take are expected to occur.*”⁵³ Thus, in the context of this MSHCP, the “planned activities likely to result in incidental take” include the siting, construction, operation, maintenance, and decommissioning of wind energy facilities. These are the only areas where incidental take is expected to occur. The Federal Register notice states that once identified, the “‘covered land’ will be the general locations where future ITPs could be issued under the MSHCP.”⁵⁴ It follows, then, that “covered land” and “HCP boundaries” are synonymous. General locations where future ITPs could be issued are the same as areas where incidental take is expected to occur.

Future ITPs should not be issued in the areas we recommend above as no-development zones and, therefore, these areas should not be included within the MSHCP’s boundaries. ESA-designated critical habitat, sensitive ecological areas, bird and bat migration corridors, red zones on ABC’s wind map, and bat hibernacula, for example, should *not* be “locations where future ITPs could be issued.” None of these areas should be afforded the protection of an ITP under

⁵¹ USFWS, *HCP/ITP Handbook*, at p. 3-11.

⁵² USFWS, *HCP/ITP Handbook*, at p. 3-11.

⁵³ USFWS, *HCP/ITP Handbook*, at p. 3-11 (emphasis added).

⁵⁴ 77 Fed. Reg. at 52754.

this MSHCP. By excluding these areas from the MSHCP's boundaries, developers seeking to build in those no-development zones will not be able to rely on the MSHCP and will therefore need to apply for individual ITPs and develop full, separate HCPs for project proposals.

Generally, we believe the approach to delineating the MSHCP's boundaries should promote the channeling of wind facility development to areas that pose the least risk to birds, bats, and other covered or vulnerable species⁵⁵ and away from areas that pose the highest risk to those species. USFWS and its planning partners should focus on impact prevention in setting the MSHCP boundaries. Impact prevention encompasses both impacts from collision/barotrauma as well as impacts from habitat displacement, loss, fragmentation, and degradation.

⁵⁵ That is, both the MSHCP-covered species as well as the second-tier vulnerable species discussed in Part I above.

PART III: AVOIDANCE AND MINIMIZATION MANAGEMENT

COMMENT III.1. The MSHCP Should Incorporate General Fine-Scale Siting Criteria for Proposed Wind Facilities.

The MSHCP should specify criteria for micro-siting of individual wind facility projects. This will provide a second habitat assessment over and above the general, landscape siting assessments recommended in the above comments.⁵⁶ Areas of suitable or potentially suitable habitat should be assessed at the individual project level for potential present and future use by covered species and prioritized for different levels of protection depending on whether the species are listed, candidate, or non-listed as well as on biological and ecological factors.

To illustrate, mandatory buffer zones of approximately five miles from Indiana bat roost trees and foraging areas should be required as a siting criterion in the MSHCP.⁵⁷ Also, project areas should be thoroughly surveyed for bird presence and habitat use. Assuming that project areas do not overlap with excluded bird areas discussed in Part II, take of birds may be able to be avoided and minimized effectively using fine-scale siting adjustments.

Areas that are not excluded from wind energy development (see Part II for recommended exclusions) may still pose a high risk to bats, birds, and other species relative to other lower-risk areas. For example, although the red areas on ABC's Wind Risk Map should be excluded, the orange areas on the Map are also important to birds and the risks posed by wind development are still substantial. The fine-scale siting criteria for such higher risk areas should be more stringent than the siting criteria used to locate facilities in low risk areas. Buffer distances, for instance, should be wider and pre- and post-construction monitoring more frequent and extensive in these higher risk areas. Similarly, in higher risk areas wind turbines should not be sited on ridges that may be followed by migrating birds. Moreover, the determination of whether a proposed set of avoidance and minimization measures is practicable should be more conservative (i.e., precautionary on the side of species protection) in higher risk areas.

⁵⁶ The USFWS's Final Land-Based Wind Energy Guidelines sets forth a multi-tier, multi-scale process relevant for siting. See USFWS, *Land-Based Wind Energy Guidelines* (Mar. 2012), available at http://www.fws.gov/windenergy/docs/WEG_final.pdf.

⁵⁷ See USFWS, *Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects* (Revised 26 October 2011), p. 9, available at <http://www.fws.gov/midwest/Endangered/mammals/inba/pdf/inbaS7and10WindGuidanceFinal26Oct2011.pdf>.

COMMENT III.2. Take of Birds Should Be Avoided and Minimized Through Design Measures in Addition to Appropriate Siting.

A. Background to Comment.

Because the presence of individual birds is not entirely predictable, sensitive siting alone is not sufficient to protect birds from collision risk. The design of wind facilities and power lines must be appropriate to ensure to the fullest extent possible that birds do not contact wind turbines, power lines, or associated structures.

B. The USFWS Land-Based Wind Energy Guidelines Should Be Mandatory Rather than Voluntary Under the Terms of the MSHCP.

USFWS recommends measures and best management practices for avoiding contact with birds and bats in the Service's Final Land-Based Wind Energy Guidelines ("the Guidelines").⁵⁸ We believe that the planning partners should incorporate the Guidelines' tiered approach and its recommendations for wind development as mandatory rather than merely voluntary.

C. Best Practices for Managing Avian/Power Line Issues Should Be Incorporated into the MSHCP's Take Minimization Plan.

The Avian Power Line Interaction Committee and USFWS jointly developed Avian Protection Plan Guidelines in 2006 to provide a framework for utilities to manage avian/power line problems.⁵⁹ The MSHCP should require wind developers to adhere to these guidelines and any updates of them in the design, construction, and operation of power transmission lines and other associated infrastructure at wind project sites. This includes, among other practices, requiring complete line marking and bird diverters, nest management, and reporting systems. Not only are many of these best practices inexpensive as compared to the cost of wind turbines and other infrastructure, they are also easily implemented and effective at minimizing avian mortality when incorporated at the beginning of a project's planning phase.

⁵⁸ USFWS, *Land-Based Wind Energy Guidelines* (Mar. 2012), Chap. 9, at pp. 49-50, available at http://www.fws.gov/windenergy/docs/WEG_final.pdf.

⁵⁹ See Avian Power Line Interaction Committee, *Suggested Practices for Avian Protection on Power Lines* (2006), available at http://www.dodpif.org/downloads/APLIC_2006_SuggestedPractices.pdf.

COMMENT III.3. In Addition to Appropriate Siting and Design, Take of Birds Should Be Minimized Through Operational Measures.

In addition to siting and design provisions and restrictions, the MSHCP should incorporate operational measures to reduce bird mortality. Nocturnally migrating birds are at increased risk of collision with turbines on nights with low-altitude cloud cover and bad weather. Birds fly at lower heights in poor weather conditions when visibility is reduced (such as with rain or fog), increasing their risk of flying in rotor swept zones. Additionally, studies have shown that birds are attracted to continuous light and are therefore at increased risk of colliding with stationary objects during bad weather events.⁶⁰

To reduce risk of collision, the MSHCP should require turbine curtailment, turbine feathering, and lighting adjustments for birds. Events like mass migration movements and weather patterns are generally short (hours or days). Operational measures therefore have the benefit of being short in duration but effective at reducing large-scale bird mortality. Turbine curtailment should be triggered during peak bird migration periods when weather conditions force birds to fly at low altitudes. The Great Lakes Regional Guidance handbook notes, for example, that in the western Lake Erie basin, westerly winds in the fall and southerly winds in the spring bring mass movements of migrating birds.⁶¹ When bad weather is predicted during these periods, turbines should be shut off to permit safe passage for birds. Turbine curtailment for both ESA-listed and non-ESA listed species is already taking place at multiple wind energy facilities in the United States, so it is not unreasonable to include it as a condition in the MSHCP.⁶² Additionally, rotor blades should be adjusted to minimize their surface in relation to the direction of migration, and developers should follow USFWS wind guideline recommendations for installing lighting in compliance with Federal Aviation Administration requirements.

⁶⁰ The Nature Conservancy, *Wind Energy: Great Lakes Regional Guidance* (2011), at p. 4, available at <http://www.glc.org/energy/wind/pdf/TNC-Great-Lakes-Regional-Guidelines.pdf>.

⁶¹ The Nature Conservancy, *Wind Energy: Great Lakes Regional Guidance* (2011), at p. 40.

⁶² We are aware of turbine curtailment taking place in Texas (for both ESA-listed and non-ESA listed species), South Dakota (for Whooping Cranes), and Maine (for Bald Eagles), but it may be happening in other locations as well since there is no publicly available national list of curtailing facilities.

COMMENT III.4. Take of Bats Should Be Avoided and Minimized Through a Turbine Curtailment Plan Based on the Best Available Science.

A. The Baseline Curtailment Plan Provided for in the MSHCP Should Reflect the Best Available Science.

Several experimental studies have examined the relationship between increases in cut-in speed and reductions in bat mortality due to turbines.⁶³ These studies are the best available science to date on the effects of curtailing cut-in speeds of wind turbines on bat fatalities.⁶⁴ The CLC has commented on the results of these studies in our submission to USFWS on Beech Ridge Energy's Draft Habitat Conservation Plan for its Beech Ridge Wind Facility in West Virginia. We incorporate our comments in Part I of that document by reference here.⁶⁵

Together, the results of the most recent turbine curtailment studies reasonably indicate that a cut-in speed of 6.5 m/s may produce a significantly larger reduction in bat fatalities compared to a cut-in speed of 5.0 m/s.⁶⁶ In addition, these studies also show that curtailing turbines to a cut-in speed of 6.5 m/s should be implemented over the entire nightly active period: from 30 minutes before sunset to 15 minutes after sunrise. Although activity levels of bats from just before sundown to just after sunrise is to some extent uncertain and may exhibit a decreasing trend over the course of the night, blade feathering during the second half of the night still reduces bat mortality substantially compared with unfeathered blades.

The MSHCP planning partners should recognize and acknowledge that the best available science points to a baseline curtailment regime for all turbines of a 6.5 m/s cut-in speed with blade feathering, from 30 minutes before sunset through 15 minutes after sunrise, during the entire active season from emergence to hibernation (which may differ depending on latitude).

⁶³ See Arnett et al., *Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. A final report submitted to the Bats and Wind Energy Cooperative* (May 2010); Good et al., *Bat Monitoring Studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana, April 13 – October 15, 2010, A report prepared for Fowler Ridge Wind Farm* (Jan. 28, 2011); see also Good et al., *Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana, April 1 – October 31, 2011, A report prepared for Fowler Ridge Wind Farm* (Jan. 31, 2012).

⁶⁴ See *id.*

⁶⁵ See Conservation Law Center, Comments on Draft EIS and Draft HCP for Beech Ridge Energy Wind Facility (Oct. 2012) (Docket ID: FWS-R5-ES-2012-0059-0032), available at <http://www.regulations.gov/#!documentDetail;D=FWS-R5-ES-2012-0059-0032>.

⁶⁶ It is possible that a cut-in speed higher than 6.5 m/s may not significantly reduce impact to bats any further, but this has yet to be established.

B. The Baseline Curtailment Plan Provided for in the MSHCP Should Minimize the Impact of Take to the Maximum Extent Practicable.

Since an applicant for an ITP must minimize the impact of take to the maximum extent practicable in order to obtain an incidental take permit, choosing a minimization plan that is reasonably likely to be *less* effective at reducing take than an alternative minimization plan will fail the permit issuance criteria, unless the applicant can show that the more effective alternative is “impracticable.” The MSHCP thus should set forth the reasoning behind selection and rejection of alternative minimization measures in a stepwise manner: first select measures that the best available science reasonably indicates will minimize take, and then examine and discuss why those measures are practicable or impracticable. If the baseline set of measures is impracticable, choose the next best alternative set of measures that will minimize take and will also be practicable.

The following steps should be implemented under the MSHCP for ITP applicants:

- Require a baseline cut-in speed of 6.5 m/s with turbine feathering below that wind speed, from 30 minutes before sunset through 15 minutes after sunrise, during the period from emergence to hibernation – the best available science reasonably indicates that this regime may minimize impact of take to covered bat species to the maximum extent practicable;
- Determine whether those measures are practicable, and justify the decision based on FWS’s guidance;
- If and only if that set of measures is shown to be impracticable, select and analyze another alternative for the project that is most likely to produce similar reductions in take but that is also practicable (e.g., cut-in speed of 6.5 m/s with feathering, for the entire night, from mid-July through mid-October).
- Take that remains after implementing such minimization measures must be mitigated to the maximum extent practicable.

C. The Operational Regime and Adaptive Management Plan Should Work in Tandem to Best Protect Covered Species.

The MSHCP should use the operational regime described above as the starting point for the research and adaptive management plan section for covered bat species. In other words, the triggers and processes for research, monitoring, and adaptive management should be based on the operational regime that the best available science reasonably indicates will minimize take to

the maximum extent practicable. Monitoring and adaptive management may be used to determine whether the selected minimization plan is performing as expected. If the selected curtailment plan is found to be performing as expected, then project developers may experiment with *incrementally* lower cut-in speeds and shorter nightly and seasonal curtailment periods using a subset of facility turbines to determine if the same effectiveness can be achieved at lower cost. Care must be taken, however, that the experimentation is not likely to unduly compromise the take reductions produced by the initial baseline measures. On the other hand, if the selected curtailment plan is found to be performing below expectations, additional measures such as shutting down or relocating problematic turbines would be implemented as specified in the adaptive management plan.

However, as discussed more extensively below in Part IV, the MSHCP's adaptive management plan should not be a substitute for specifying and implementing those baseline operational measures that the best available science reasonably indicates will best avoid and minimize impacts to covered species. The adaptive management plan should not be used to lock in a curtailment regime that the best available science now indicates is sub-par relative to other regimes under the rationale that "more research is needed." Given the scope of this MSHCP, USFWS and its planning partners must proceed cautiously. If the planning partners feel that more research and experimentation is needed to test hypotheses about curtailment regimes, that research and experimentation should be conducted incrementally at a small scale and should proceed from more restrictive to less restrictive, not vice versa.

COMMENT III.5. Measures to Avoid and Minimize Take of Birds and Bats Must Be Consistent and Integrated.

Measures to avoid and minimize take of birds must be integrated with measures for bats. Avoiding and minimizing direct take of bats at wind turbines may require some measures not relevant or not protective for birds, such as adjustment of wind turbine height,⁶⁷ reducing operation during periods of low wind speeds,⁶⁸ and use of electromagnetic fields for

⁶⁷ Robert M.R. Barclay et al., *Variation in Bat and Bird Fatalities at Wind Energy Facilities: Assessing the Effects of Rotor Size and Tower Height*, 85 Canadian J. of Zoology 3, 381-387 (2007), available at <http://www.nrcresearchpress.com/doi/abs/10.1139/Z07-011>.

⁶⁸ Edward B. Arnett et al., *Effectiveness of Changing Wind Turbine Cut-in Speed to Reduce Bat Fatalities at Wind Facilities*, Bat Conservation International (Apr. 2009), available at http://www.batsandwind.org/pdf/Curtailment_2008_Final_Report.pdf.

deterrence.⁶⁹ Thus, measures that focus on avian species alone will not be sufficient to protect bats as well, and vice versa. Not only must the MSHCP provide a plan for implementing avoidance measures for both birds and bats, it must also find ways to avoid conflicts between measures for different taxa.

⁶⁹ Barry Nicholls & Paul A. Racey, *Bats Avoid Radar Installations: Could Electromagnetic Fields Deter Bats from Colliding with Wind Turbines?*, PLoS ONE 2(3), at 1 (2007), available at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000297>.

PART IV: ADAPTIVE MANAGEMENT, CHANGED CIRCUMSTANCES, AND MONITORING

COMMENT IV.1. Adaptive Management Provisions Should Be Incorporated With Clear and Well-Defined Implementation Criteria.

A. Background to Comment.

Achieving the objectives of this MSHCP is going to be a complex undertaking. There are clear goals to be met (e.g., remaining within allowable take levels for the ITP) and a mandate to protect species (e.g., large-scale wind energy development is taking place in areas with wildlife species protected by the ESA, BGEPA, and MBTA), but there is significant uncertainty about how the goals can be achieved (e.g., how can take levels be managed given the large geographic area and multiple wind energy projects that could potentially take protected wildlife). Adaptive management, if properly structured and implemented, will provide a structured method for managing this uncertainty and complexity while still achieving the goals.

Adaptive management may be implemented as part of an HCP for several reasons: (1) to determine whether implemented minimization and mitigation measures are as effective as predicted and to modify the measures if not; (2) to resolve a specific uncertainty about the effectiveness of planned minimization and mitigation measures; (3) to determine the potential effects of the activity on the species covered in the HCP/ITP; and (4) to test hypotheses about the relative effectiveness or feasibility of measures that are not planned but which may be as effective as the planned measures. Especially for the third and fourth uses of adaptive management, experiments must not pose too much risk to the covered species.⁷⁰

The HCP Handbook emphasizes that while the “base mitigation strategy or initial minimization and mitigation measures which are implemented must be sufficiently vigorous so that the Service may reasonably believe that they will be successful,” an “adaptive management approach is particularly useful when significant questions remain regarding an HCP’s initial mitigation strategy.”⁷¹ The Five-Point Policy states that adaptive management is “essential” for HCPs that pose significant risks to species as a result of data and information gaps.

⁷⁰ 65 Fed. Reg. 35242, 35252 (*Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process*) (June 1, 2000) [hereinafter “HCP/ITP Handbook Addendum”].

⁷¹ USFWS, *HCP/ITP Handbook*, at p. 3-25.

It is important to note that a commitment to adaptive management is not by itself a valid mitigation measure. Adaptive management seeks to address uncertainties about impacts to species and allows for the implementation of measures that reduce, remove, or mitigate impacts of take.⁷² Reducing uncertainty “does not compensate for take that occurs, and therefore, is not a mitigation measure.”⁷³

B. The Adaptive Management Plan Should Cautiously Allow For the Implementation of Updated Minimization and Mitigation Techniques.

While there is consensus in the scientific community that wind facilities cause mortality in birds, bats, and other species and can result in habitat degradation, results of monitoring and from studies of effects of wind turbines on bats and birds shed new light on the appropriateness of existing mitigation and minimization techniques. In addition, there is a high level of risk associated with this MSHCP, considering that it is one of the first of its kind and one of the first on this geographic scale. In the face of such uncertainty and risk and given the scale of this MSHCP, the conservation program for the Midwest region should be “cautious initially and adjusted later based on new information.”⁷⁴ The adaptive management strategy should therefore employ active experiments only if experimental treatments reflect relatively small and incremental adjustments to initial baseline measures. The adaptive management strategy should also require early and frequent monitoring and adjustments based on monitoring results. Indeed, monitoring is the key element of a successful adaptive management strategy and, as discussed further below, must be designed to allow the efficient reporting and dissemination of monitoring data to permit timely adjustments to the conservation plan.

To illustrate with an example, the adaptive management plan for covered bat species should contain triggers and specific modifications to the turbine curtailment regime if roosting or maternity sites are newly identified. The Indiana Bat draft recovery plan notes that “[b]ecause maternity colonies are widely dispersed during the summer and difficult to locate, all the combined summer survey efforts have found only a fraction of the maternity colonies presumed to exist based on the rangewide population estimates derived from winter hibernacula surveys. . .

⁷² USFWS, *Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects* (Revised 26 Oct. 2011), question 73, at 49, available at

<http://www.fws.gov/midwest/endangered/mammals/inba/pdf/inbaS7and10WindGuidanceFinal26Oct2011.pdf>.

⁷³ *Id.* at 49.

⁷⁴ USFWS, *HCP/ITP Handbook Addendum*, at p. 35252.

Regardless of reasonable disagreements regarding the average colony size, the geographic locations of the majority of Indiana bat maternity colonies remain unknown.”⁷⁵ Thus, the adaptive management plan and the changed circumstances provisions of the MSHCP should provide for locating previously unobserved roosting sites and maternity colonies within commuting distance of projects and provide for specific modifications over and above the baseline minimization and mitigation plans if any are found.

C. The Adaptive Management Plan Must Not Be a Substitute for Avoidance, Minimization, and Mitigation Measures that Reflect the Best Available Science.

Every adaptive management plan should begin with identifying the key uncertainties and the questions that need to be addressed to resolve the uncertainties. “Identifying the uncertainty to be addressed is the foundation of the adaptive management strategy.”⁷⁶ A second foundational feature of an adaptive management plan is that adaptive management cannot substitute for a showing of reasonable certainty that the substantive criteria will be met.⁷⁷ An important role of adaptive management is to resolve key uncertainties while satisfying statutory and regulatory standards. Specifically, the MSHCP cannot use uncertainty as a justification for holding back measures that are reasonably indicated by the best available science to minimize and mitigate the impact of take to the maximum extent practicable.⁷⁸

COMMENT IV.2. The Range of Responses to Information Gained Through Adaptive Management and to Changed Circumstances Must Be Clearly Specified in the MSHCP.

A common shortcoming of draft HCPs for wind facilities has been the failure to adequately specify the range of measures that will be implemented in response to new

⁷⁵ USFWS, *Indiana Bat Draft Recovery Plan, First Revision* (Apr. 2007), at p. 27, available at http://www.fws.gov/midwest/endangered/mammals/inba/pdf/inba_fnldrftrecpln_apr07.pdf.

⁷⁶ USFWS, *HCP/ITP Handbook Addendum*, at p. 35252.

⁷⁷ J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts*, 95 Minn. L. Rev. 424, 472 (2010).

⁷⁸ This view is supported by *Greater Yellowstone Coalition, Inc. v. Servheen*. In *Greater Yellowstone* the court addressed the agency’s plan to remove the grizzly bear population from the threatened species list in the face of substantial uncertainties about the impact of whitebark pine declines. The agency decided to rely on monitoring and adaptive management rather than ensure that the applicable ESA standards were satisfied. The court stated, “Just as it is not enough simply to invoke ‘scientific uncertainty’ to justify an agency action, it is not enough to invoke ‘adaptive management’ as an answer to scientific uncertainty.” *Greater Yellowstone Coalition, Inc. v. Servheen*, 665 F.3d 1015, 1028–29 (9th Cir. 2011).

information gained through adaptive management or in response to the triggering of changed circumstances provisions.

According to USFWS, “[a]daptive management strategies, if used, are part of [the HCP] provisions, and their implementation becomes part of a properly implemented conservation plan”⁷⁹ but “[a]daptive management should not be a catchall for every uncertainty or a means to address issues that could not be resolved during negotiations of the HCP.”⁸⁰ The adaptive management plan must clearly and with specificity state the range of possible operating conservation program adjustments that would be triggered by new information.⁸¹ “Whenever an adaptive management strategy is used, the approved HCP must outline the agreed-upon future changes to the operating conservation program.”⁸² This requirement is relatively straightforward. If new information reveals that take is greater than expected or initial measures are not as effective as expected, then one or more additional *specified* measures are triggered depending on the deviation. Alternatively, if appropriate responses to new information are uncertain initially, experimentation may be included as part of the adaptive management plan – for example, a comparison of the effectiveness of three cut-in speeds. The plan would then call for implementation of the treatment alternative that produces the best result. Either way, the range of additional measures can be described with specificity in the HCP – i.e., they are either known additional measures or known treatment alternatives in planned experiments. An adaptive management plan is not an excuse for failing to specify a range of measures that will be triggered based on specified scenarios, even though the scenario that will occur and the precise measure called for may be uncertain at the time of permit issuance.

According to USFWS, adaptive management is compatible with the No Surprises policy only if the HCP, ITP, and Implementing Agreement “clearly state the range of possible operating conservation program adjustments due to significant new information, risk, or uncertainty.”⁸³ The description of such adjustments must be specific enough to delineate “the limits of what resource commitments may be required of the permittee” so that the applicant can “assess the potential economic impacts of adjustments before agreeing to the HCP.”⁸⁴ An adaptive

⁷⁹ USFWS, *HCP/ITP Handbook Addendum*, at p. 35253.

⁸⁰ USFWS, *HCP/ITP Handbook Addendum*, at p. 35252.

⁸¹ *NRDC v. Kempthorne*, 506 F.Supp.2d 322, 356–57 (E.D. Cal. 2007).

⁸² USFWS, *HCP/ITP Handbook Addendum*, at p. 35252.

⁸³ USFWS, *HCP/ITP Handbook Addendum*, at p. 35253.

⁸⁴ USFWS, *HCP/ITP Handbook Addendum*, at p. 35253.

management plan that sets forth only a process for meetings, consultation, and recommendations, or that sets forth only vague and generalized responses to new information, is insufficient under the ESA⁸⁵ and would not be compatible with No Surprises assurances.

Under the “No Surprises” policy, if the status of a species worsens because of changed circumstances the responsibility for implementing additional conservation measures falls on the federal government and all other entities except the HCP permittee – the entity taking the species – unless the specific measures deemed necessary to respond to the changed circumstances are “provided for” in the HCP. Changed circumstances, as opposed to unforeseen circumstances, “can reasonably be anticipated and planned for.”⁸⁶ The regulations provide as follows with respect to changed circumstances:

(i) Changed circumstances provided for in the plan. If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and were provided for in the plan’s operating conservation program, the permittee will implement the measures specified in the plan.

(ii) Changed circumstances not provided for in the plan. If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and such measures were not provided for in the plan’s operating conservation program, the Director will not require any conservation and mitigation measures in addition to those provided for in the plan without the consent of the permittee, provided the plan is being properly implemented.⁸⁷

If operational or mitigation measures are not “provided for” in the MSHCP, those measures cannot be required of wind energy facilities for the term of the associated ITPs. USFWS has stated that, with respect to changed circumstances, “[t]he HCP, incidental take permit, and IA, if any, must describe the agreed upon range of management and/or mitigation actions and the process by which the management and funding decisions are made and implemented.”⁸⁸ Therefore, the MSHCP’s changed circumstances plan must describe a range of specific agreed-upon measures and must commit to the implementation of one or more of those measures in response to the changed circumstances scenarios presented. It is insufficient to commit only to “confer” with USFWS or to “research” a solution to the problem without specifying a range of possible actions and without committing to implementation. The

⁸⁵ *NRDC v. Kempthorne*, 506 F.Supp.2d at 356–57.

⁸⁶ USFWS, *HCP/ITP Handbook*, at p. 3-28.

⁸⁷ 50 C.F.R. § 17.22(b)(5)(i)-(ii).

⁸⁸ USFWS, *HCP/ITP Handbook Addendum*, at p. 35253.

specificity with which the range of responses to changed circumstances must be described in the MSHCP must be sufficient to delineate “the limits of the resource commitments that may be required of the permittee.”⁸⁹ Thus, vague and generalized descriptions such as “additional operational measures” are insufficient because such statements do not allow delineation of the resources that can be required of the permittee over the term of the ITP/HCP.

COMMENT IV.3. The MSHCP Should Implement a Robust Mortality Monitoring Program.

Monitoring will be a necessary part of the MSHCP. This MSHCP could be a model for other efforts if it includes a robust mortality monitoring program, funded by permit applicants. The monitoring program should contain the following elements:

1. The monitoring program should feed information into an adaptive management approach towards decision making about future wind farm proposals. USFWS already has guidelines for adaptive management in the context of structured decision making that should be followed.
2. Design and implementation of the monitoring program should be overseen by an independent science advisory group (including representatives from multiple agencies, academia, and NGOs). While USFWS facilitators could assist in the design of this program, they should not be voting members of the working group.
3. Standardized data collection protocols that have been peer-reviewed by the science advisory working group should be implemented at all project sites.
4. Monitoring protocols should have sufficient statistical power to detect trends in local populations over the relevant timeframe.
5. Data entry into a central repository that has been designed by database professionals (and is freely accessible to the science advisory group and the public for analysis) should be a mandatory permit condition. Failure to meet this condition should have consequences.
6. Bi-annual analyses of this database (documented in written reports) should be produced by scientists/statisticians approved by the science advisory group.
7. These bi-annual monitoring reports should be reviewed and evaluated in public forums involving USFWS, industry professionals, NGOs, academics and other experts. Mitigation practices should be evaluated in light of the monitoring data and reports.

⁸⁹ USFWS, *HCP/ITP Handbook Addendum*, at p. 35253 (stating also, with respect to changed circumstances, “[t]he HCP, incidental take permit, and IA, if any, must describe the agreed upon range of management and/or mitigation actions and the process by which the management and funding decisions are made and implemented.”).

8. A National Academy of Sciences panel should evaluate the success of the monitoring program once every 2 to 3 years.
9. The recommendations on pre-construction and post-construction mortality study design appearing in the USFWS Land-Based Wind Energy Guidelines should be followed.

PART V: PERMIT STRUCTURE

COMMENT V.1. Second Tier Analysis for Site-Specific Impacts Must Be Incorporated Into the Permitting Structure.

A. Background to Comment.

The CEQ defines “tiering” as “the process of addressing a broad, general program, policy, or proposal in an initial environmental impact statement (EIS), and analyzing a narrower site-specific proposal, related to the initial program, plan or policy in a subsequent EIS.”⁹⁰ Tiering is appropriate in two situations:

- (a) From a program, plan, or policy environmental impact statement to a program, plan, or policy statement or analysis of lesser scope or to a site-specific statement or analysis.
- (b) From an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage (such as environmental mitigation).⁹¹

Furthermore, CEQ guidance material provides that:

...where a Federal agency adopts a formal plan which will be executed throughout a particular region, and later proposes a specific activity to implement that plan in the same region, both actions need to be analyzed under NEPA to determine whether they are major actions which will significantly affect the environment. If...both actions will be subject to the EIS requirement...[and] tiering is utilized, the site-specific EIS contains a summary of the issues discussed in the first statement...[and] the site-specific statement would focus primarily on the issues relevant to the specific proposal.⁹²

The Federal Register notice soliciting these comments sets forth two main MSHCP structures: a template/umbrella MSHCP and a programmatic MSHCP. Under the umbrella approach, “the Service would issue individual ITPs to applicants that agree to implement the MSHCP.” Under the programmatic approach, “each State agency would apply for and receive an ITP and would issue certificates of inclusion to wind energy companies that agreed to

⁹⁰ 48 Fed. Reg. 34263 (*Guidance Regarding NEPA Regulations*) (July 28, 1983); *see also* 40 C.F.R. § 1508.28.

⁹¹ 40 C.F.R. § 1508.28.

⁹² 48 Fed. Reg. at 34268.

implement the MSHCP at their facility.”⁹³ According to USFWS, at this time it is anticipated that the umbrella approach – in which individual ITPs would be issued – is the more likely for this MSHCP, although the programmatic approach and other permit structure options are being considered.⁹⁴ Whatever permit structure is adopted, USFWS expects that the MSHCP “would meet all ITP issuance criteria found at 50 CFR 13.21, 17.22(b), and 17.32(b),” and would be evaluated under NEPA and Section 7 of the ESA only once – that is, “the partners envision that under any permit approach, no additional NEPA or Section 7 analysis would occur.”⁹⁵

B. The Permit Structure Will Need to Include Site-Specific and Project-Specific Analysis of Impacts and Risks.

The agency’s description in the Federal Register notice suggests that at the time a company applies for an ITP or a certificate of inclusion, the USFWS (under the umbrella approach) or the State conservation agency (under the programmatic approach) would issue the ITP or certificate of inclusion if the company “agree[s] to implement the MSHCP at their facility.” USFWS has not provided sufficient information in the Federal Register notice about whether specific project locations are currently known or will be included in the final EIS and MSHCP.

Regardless of which permitting option is chosen, unless the proposed locations of individual projects covered under the MSHCP are included in the final EIS and MSHCP, or unless the siting of future projects is confined to pre-evaluated locations, the permitting process must provide for a second tier, more detailed assessment of impacts in addition to the single programmatic EIS. Failure to analyze potential impacts and risks at the site or project scale would most likely leave impacts and risks unanalyzed.⁹⁶

A programmatic-level EIS, without analysis of the proposed locations of wind projects, would not be able to address site-specific details of project impacts, costs, and mitigation measures. The programmatic analysis emphasizes cumulative effects of multiple future activities, whereas a second tier analysis would emphasize direct and indirect effects of a single

⁹³ 77 Fed. Reg. at 52755.

⁹⁴ 77 Fed. Reg. at 52755.

⁹⁵ 77 Fed. Reg. at 52755.

⁹⁶ This is made clear in USFWS’s Land Based Wind Energy Guidelines, which calls for site characterization and and field studies to document site wildlife and habitat after a landscape scale siting evaluation. USFWS, *Land-Based Wind Energy Guidelines* (Mar. 23, 2012), Chapters 3 & 4.

activity.⁹⁷ The broad geographic scope of most programmatic NEPA analyses requires different data sources than project-level analyses. The remaining question is what type of second tier compliance document – e.g., a site-specific EIS or a site-specific EA – is required under NEPA, which will be answered independently for each separate project.⁹⁸

Moreover, the public should have the opportunity to comment on site-specific wind project proposals and to challenge proposed locations, which would not be possible without an analysis of the site- and project-specific impacts and risks.

The requirements of the ESA also indicate the need for a site-specific or project-specific analysis of impacts. The baseline and cumulative effects analysis required by ESA Section 7 depends on the delineation of an “action area,” which typically is separately delineated for each project. ESA regulations define the term “action area” as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.”⁹⁹ The action area is a biological determination of the reach of the proposed action on listed species. Careful delineation and explanation of the chosen action area is important because the determination of the environmental baseline and cumulative effects are tied to the action area.¹⁰⁰ Determining the scope of an action area requires application of scientific methodology and the agency must explain the “scientific methodology, relevant facts, or rational connections linking the project’s potential impacts” to the action area boundaries to enable a reviewing court to determine whether the action area was properly conceived.¹⁰¹ Cumulative effects analyses for action areas delineated for sited wind energy projects may not be equivalent to an analysis of cumulative effects for a programmatic or regional-scale action area or to the larger-scale cumulative impact analysis required by NEPA. For example, a cluster of projects in a particular local area may have disproportionate cumulative effects that are not revealed by a larger scale cumulative effects analysis that does not consider location-specific information. Thus, a failure to delineate project-specific action areas and to then analyze project-specific baselines and cumulative effects may leave impacts and risks unanalyzed and ESA requirements unfulfilled.

⁹⁷ See USFWS, *Land-Based Wind Energy Guidelines* (Mar. 23, 2012), Chapters 3 & 4.

⁹⁸ See CEQ regulation at 40 C.F.R. § 1508.28; 48 Fed. Reg. 34263 (*Guidance Regarding NEPA Regulations*) (July 28, 1983).

⁹⁹ 50 C.F.R. § 402.02. Section 7 of the ESA applies to the USFWS issuance of an ITP. See USFWS, *HCP/ITP Handbook*, at pp. 6-12 to 6-14.

¹⁰⁰ *Defenders of Wildlife v. Babbitt*, 130 F.Supp.2d 121, 129 (D.D.C. 2001).

¹⁰¹ *Native Ecosystems Council v. Dombeck*, 304 F.3d 886, 902 (9th Cir. 2002).

COMMENT V.2. The ITPs or Certificates of Inclusion May Need to Incorporate Site-Specific and Project-Specific Avoidance, Minimization, and Mitigation Measures.

The main potential shortcoming of both the umbrella and programmatic permitting structures is that it is unclear how the features of specific project locations will be assessed and incorporated into avoidance, minimization, and mitigation measures. The planning partners should explain as soon as possible in the scoping process how each permitting structure will tailor allowable take, terms and conditions, minimization and mitigation measures, and adaptive management provisions to the specific characteristics of individual wind projects, and under what circumstances this is necessary.

Required determinations may not be able to be made at the program level. For example, USFWS may not be able to programmatically determine whether all wind energy projects to be covered under the MSHCP will meet the ITP issuance criteria – in particular the criterion that the impacts of take will be minimized and mitigated “to the maximum extent practicable” – without knowing specifically where those projects will be sited and what local impacts they may have. On one hand it may be possible to programmatically identify measures that the best available science indicates will likely minimize or mitigate take of a covered species. However, if the agency interprets the term “practicability” to depend on the estimate of local impacts, the resources of the project proponent, or the localized costs of alternative turbine configurations and operations, whether such measures are “practicable” may not be clear until the project owner is known and a specific site is characterized and studied. In other words, how can USFWS ensure that the program-level MSHCP “would meet all ITP issuance criteria found at 50 CFR 13.21, 17.22(b), and 17.32(b)”¹⁰² if the “practicability” determination depends on site- or project-specific characteristics? Moreover, at least one court has ruled that USFWS cannot impose compensatory mitigation that is not tailored to the level of unavoidable impact that remains after practicable avoidance and minimization measures are accounted for. It is unclear how USFWS can specify mitigation measures without knowing the level of practicable avoidance and minimization, which in turn may depend on local factors.

Of the two proposed permit structures as currently described, the umbrella option has the potential to allow USFWS to tailor the allowable take and the measures of the MSHCP to the

¹⁰² 77 Fed. Reg. at 52755.

specific characteristics and needs of each individual project (characteristics and needs that might change due to the project's owner, size, location, etc.) because an individual ITP would be issued for each project. Such tailoring would benefit permittees, who will not be saddled with a permit that is overly broad or narrow, as could be the case under a state-held ITP. Issuing individual ITPs also allows more flexibility in setting take limits and in the agency's response to monitoring data on takings. Presumably, at the time the MSHCP is evaluated, the agency would have to estimate a cumulative allowable take for each covered species over the entire MSHCP plan area. With the umbrella option, the agency would be able to fine tune allowable take at finer spatial scales to account for differences in species distributions, ecological sensitivity, and anthropogenic threats across the Midwest region. Note, however, that even with the umbrella option with individual ITPs it may not be possible for the agency to determine satisfaction of the permit issuance criteria based on the MSHCP before knowing the locations, characteristics, and owners of the covered wind energy projects.

The programmatic option, which apparently would use a "certificate of inclusion" to bind individual projects to the MSHCP and state-held ITP, would be especially problematic if it is not possible to determine satisfaction of the permit issuance criteria before knowing the locations, characteristics, and owners of the covered wind energy projects. Neither USFWS regulations nor, to our knowledge, USFWS guidance describes certificates of inclusion. NOAA Fisheries Service regulations do have such regulations,¹⁰³ but the criteria for issuing a certificate under those regulations do not include a finding that the permittee will minimize and mitigate the impacts of take to the maximum extent practicable. If the NOAA regulations are used for this ITP process, they would thus require only findings that the applicant will be engaged in the activity covered by the MSHCP and that the applicant will fund and implement the applicable measures in the MSHCP (measures which are programmatic and not site or project specific). This is inadequate without an additional requirement of a finding that the permittee will minimize and mitigate the impacts of take to the maximum extent practicable. Unless USFWS issues regulations or guidance on certificates of inclusion, it appears unlikely that such certificates will require or include any consideration of site- or project-specific characteristics.

¹⁰³ 50 C.F.R. § 222.307(f).

COMMENT V.3. ESA Section 7 Consultation Is Required for Each Project if Wind Projects Are Allowed in Designated Critical Habitat.

The descriptions of the structural options indicate that only one ESA Section 7 consultation will be completed for the single MSHCP, and that Section 7 consultations or analyses will not be applied to individual ITP issuances or certificates of inclusion. The potential problem with this scheme is that at the time the single MSHCP is evaluated by the agency, the specific locations of some wind projects will likely be unknown to USFWS or unrevealed to the public. Unless all designated critical habitat, regardless of species, is declared off limits to wind energy projects under the MSHCP, which we recommend in Part II above, a site- and project-specific Section 7 analysis will be required in order to determine whether the project will result in “destruction or adverse modification” of designated critical habitat. Destruction or adverse modification cannot be assessed without knowing the specific locations and extent of the wind projects.

This determination of destruction or adverse modification would not otherwise be made pursuant to an ITP issuance or certificate of inclusion under ESA Section 10. The questions asked during a Section 7 consultation are not identical to the questions asked prior to Section 10 ITP issuance. Specifically, before issuing an ITP the agency must ask whether the taking “will not appreciably reduce the likelihood of survival and recovery of the species in the wild”:

(2) Issuance criteria. (i) Upon receiving an application completed in accordance with paragraph (b)(1) of this section, the Director will decide whether or not a permit should be issued. The Director shall consider the general issuance criteria in § 13.21(b) of this subchapter, except for § 13.21(b)(4), and shall issue the permit if he or she finds that: (A) The taking will be incidental; (B) The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such takings; (C) The applicant will ensure that adequate funding for the conservation plan and procedures to deal with unforeseen circumstances will be provided; (D) *The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild*; (E) The measures, if any, required under paragraph (b)(1)(iii)(D) of this section will be met; and (F) He or she has received such other assurances as he or she may require that the plan will be implemented.¹⁰⁴

In contrast, during a Section 7 consultation the agency must ask whether the agency action “is not likely to jeopardize the continued existence of any endangered species or threatened species

¹⁰⁴ 50 C.F.R. § 17.22(b)(2) (emphasis added).

or result in the destruction or adverse modification of [designated critical] habitat of such species.”¹⁰⁵ “Destruction or adverse modification” means a direct or indirect alteration that appreciably diminishes the value of critical habitat for *either* the survival *or* recovery of a listed species.¹⁰⁶ The “destruction or adverse modification” standard accounts for impacts to species recovery whereas the ITP issuance standard, in contrast, accounts only for species survival and not recovery.¹⁰⁷ The “destruction or adverse modification” standard does not appear in the § 17.22 or § 17.32 ITP issuance criteria.

COMMENT V.4. Permittees Must Be Held Accountable for Noncompliance Under a Programmatic Permit Structure.

Under an umbrella permit approach, which would require individual ITPs for each wind project, each wind facility can be held individually accountable for noncompliance under its individual ITP. Under that approach USFWS plays an active and clear role in monitoring compliance with take limits and triggers for the implementation of adaptive management measures. Monitoring and assuring compliance with take limits and permit terms under a state-held ITP could pose difficulties, however. If the planning partners choose to proceed with the programmatic permit structure for the MSHCP, they must explain how a wind facility’s certificate of inclusion under a state-held ITP may be suspended or revoked, and how the suspension or revocation of a facility’s certificate of inclusion will affect the validity of the state ITP. This is especially important if, as we recommend above, certificates of inclusion are tailored to individual facilities. The MSHCP/ITP permit structure must provide a documented avenue through which USFWS, the state conservation agencies, and the public can enforce permit conditions and project adherence to permit terms.

COMMENT V.5. An Independent Oversight and Advisory Committee Is Important and Needed for a Program of this Breadth.

A. Background to Comment.

The USFWS’s Five-Point Policy states the following about oversight committees:

¹⁰⁵ 16 U.S.C. § 1536(a)(2).

¹⁰⁶ 50 C.F.R. § 402.02. *See also* Butte Environmental Council v. USACE, 620 F.3d 936 (9th Cir. 2010) (interpreting “adverse modification”); Gifford Pinchot Task Force v. U.S. Fish & Wildlife Services, 378 F.3d 1059 (9th Cir. 2004) (same).

¹⁰⁷ *See* Spirit of the Sage Council v. Kempthorne, 511 F. Supp.2d 31, 43–44 (D.D.C. 2007).

For large-scale or regional HCPs, oversight committees, made up of representatives from significantly affected entities...are often used to ensure proper and periodic review of the monitoring program and to ensure that each program properly implements the terms and conditions of the incidental take permit...For large-scale or regional HCPs, oversight committees should periodically evaluate the permittee's implementation of the HCP, its incidental take permit, and [Implementation Agreement (IA)] and the success of the operating conservation program in reaching its identified biological goals and objectives. Such committees usually include species experts and representatives of the permittee, the Services, and other affected agencies and entities. Submitting the committee's findings to recognized experts in pertinent fields (*e.g.*, conservation biologists or restoration specialists) for review or having technical experts conduct field investigations to assess implementation of the terms and conditions would also be beneficial. Because the formation of these committees may be subject to the Federal Advisory Committee Act, the role of the participants and the purpose of the meetings must be clearly identified. Oversight committees should meet at least annually and review implementation of the monitoring program and filing of reports as defined in the HCP, permit, and/or IA, if one is used.¹⁰⁸

The Five-Point Policy also encourages the use of science advisory committees, which are active during both HCP development and implementation phases:

The Services encourage the use of scientific advisory committees during the development and implementation of an HCP. The integration of a scientific advisory committee and perhaps other stakeholders improves the development and implementation of any adaptive management strategy. Advisory committees can assist the Services and applicants in identifying key components of uncertainty and determining alternative strategies for addressing that uncertainty. We also encourage the use of peer review for an HCP. An applicant, with guidance from the Services, may seek independent scientific review of specific sections of an HCP and its operating conservation strategy to ensure the use of the best scientific information.¹⁰⁹

Lastly, USFWS's HCP Handbook, Chapter 3.A.3, states the following regarding HCP steering committees, which assist with the development of the HCP:

Steering committees are particularly useful in regional HCPs, especially those in which the prospective permittee is a state or local government agency, and are recommended for these types of HCP efforts.¹¹⁰

¹⁰⁸ USFWS, *HCP/ITP Handbook Addendum*, at p. 35255.

¹⁰⁹ USFWS, *HCP/ITP Handbook Addendum*, at p. 35256.

¹¹⁰ USFWS, *HCP/ITP Handbook*, at p. 3-3.

B. Oversight and Advisory Committees Should Be Used.

Development of an MSHCP and ITP(s) at this spatial scale and involving this many species is replete with uncertainties. Oversight and science advisory committees, independent from potential future permit holders and representing a range of viewpoints, should be assembled for implementation of this proposed MSHCP.

COMMENT V.6. Whichever Permit Structure is Chosen, USFWS Cannot Sub-Delegate Particular Responsibilities.

A. Background to Comment.

The HCP Handbook states that for “large-scale HCPs, monitoring programs should include periodic accountings of take, surveys to determine species status in project areas or mitigation habitats, and progress reports on fulfillment of mitigation requirements.”¹¹¹ The Five-Point Policy also provides that “[t]he Service should verify adherence to the terms and conditions of the incidental take permit, HCP, IA, and any other related agreements and should ensure that incidental take of the covered species does not exceed the level authorized under the incidental take permit.”¹¹² The above USFWS policy expressly reflects the oversight role of the agency.

B. USFWS Must Have an Active Monitoring Role Under Any Permit Structure.

In the context of HCPs and ITPs, USFWS has repeatedly assumed an active role as an overseer – not only by working alongside ITP holders to set biological objectives and create adaptive management plans but also by supervising ITP compliance and, if necessary, implementing the agency’s power of permit revocation.¹¹³ The Programmatic option appears to relieve USFWS of its supervisory role after the ITPs are granted to the state agencies – this option relies on the state conservation agencies to exclusively monitor *and determine* compliance of the individual wind companies and projects with the terms and conditions of certificates of inclusion. The option as described does not explicitly provide for USFWS compliance oversight, such as site visits.

¹¹¹ USFWS, *HCP/ITP Handbook*, at p. 3-26.

¹¹² USFWS, *HCP/ITP Handbook Addendum*, at p. 35254.

¹¹³ See e.g., 69 Fed. Reg. 71723 (*Endangered Species Act Incidental Take Permit Revocation Regulations*) (Dec. 10, 2004).

In general, the ESA and implementing regulations set forth a number of decision making responsibilities for the Service. Regardless of which MSHCP/ITP structure the planning partners choose to implement, the ESA regulations prescribe a set of decisions that may not be sub-delegated by USFWS. These decisions include whether each project satisfies ITP criteria, whether the permit should be suspended or revoked, whether permit succession or transfer should be authorized, and whether and how the permit should be amended. At this stage of program development, USFWS should clarify its role and level of oversight with respect to these and similar decisions.

PART VI: COORDINATION WITH ESA SECTION 7

COMMENT VI.1. To Assist USFWS in Meeting ESA Section 7 Consultation Requirements, the MSHCP Should Carefully Consider the Full Spectrum of Potential Effects of Issuing ITPs on a Regional Scale.

The ESA seeks to ensure by way of the Section 7 consultation requirement that “any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification” of critical habitat.¹¹⁴ While consultation is the federal agency’s responsibility rather than the applicant’s, the HCP Handbook urges ITP applicants to “ensure that those considerations required of the Services by section 7 have been addressed in the HCP.”¹¹⁵ Thus, USFWS considers the HCP development process under Section 10 of the ESA and the consultation process under Section 7 to be concurrent and related rather than independent and sequential.¹¹⁶ If this is to be the case here, the MSHCP must adequately meet Section 10 issuance criteria as well as Section 7 standards.

In satisfying the Section 7 consultation requirement, USFWS must “[e]valuate the effects of the action and cumulative effects on the listed species or critical habitat.”¹¹⁷ “Effects of the action” means “the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline.”¹¹⁸ “Cumulative effects” refers to “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area.”¹¹⁹ Action area, in turn, constitutes “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.”¹²⁰

In general, there is growing concern in the scientific community regarding the potential for bat and bird kills and population declines given the rapid proliferation of wind power facilities and the large- scale mortality that has occurred at some facilities. The USFWS’s direct,

¹¹⁴ 16 U.S.C. § 1536(a)(2); USFWS, *HCP/ITP Handbook*, at p. 3-15.

¹¹⁵ USFWS, *HCP/ITP Handbook*, at p. 3-15.

¹¹⁶ USFWS, *HCP/ITP Handbook*, at p. 3-16.

¹¹⁷ 50 C.F.R. § 402.14(g)(3).

¹¹⁸ 50 C.F.R. § 402.02.

¹¹⁹ 50 C.F.R. § 402.02.

¹²⁰ 50 C.F.R. § 402.02.

indirect, and cumulative effects analysis for this MSHCP must consider the potential impacts to all threatened and endangered species and designated critical habitat from at least the following sources: (1) wind facilities not covered under the proposed MSHCP; (2) other HCPs and ITPs (and incidental take statements) issued in the region; (3) construction of transmission and distribution lines associated with the wind energy facilities; (4) other causes of habitat loss and fragmentation affecting the species such as logging, agriculture, oil and gas development, power line construction, agricultural conversion, and residential development; (5) shifts in summer, stopover, and winter habitats and in migration pathways due to climate change; (6) disease and parasites (e.g., White Nose Syndrome); (7) predation; (8) competition between species; (9) environmental contaminants (not just “pesticides”); (10) collisions with man-made objects; and (11) any other threats to the species of which USFWS is aware.

COMMENT VI.2. The Duration of the MSHCP/ITP(s) Should Be Specified to Direct the Cumulative Effects Analysis.

ESA Section 7 specifically notes that the Service’s responsibility is to “[f]ormulate its biological opinion as to whether the action, *taken together with cumulative effects*, is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.”¹²¹ In order to properly assess cumulative effects and thereby assist USFWS in reaching a biological opinion, the planning partners will need to specify the proposed duration for the MSHCP and ITP(s). The cumulative effects analysis is tied to foreseeable future events that correspond to the timeframe of the projects’ impacts or the timeframe of the MSHCP, whichever is longer. Without a specified duration, the scope of the cumulative effects analysis cannot be adequately planned.

¹²¹ 50 C.F.R. § 402.14(g)(4) (emphasis added).

SUMMARY

In summary, the MSHCP should cover additional ESA endangered, threatened, and candidate species. It should also provide a second tier of protection for bird species that are vulnerable to the collision and habitat risks of wind development, and which have been identified by USFWS and ABC as in need of conservation action. Wind energy development should be excluded from ecologically valuable areas, such as in designated critical habitat, near bat hibernacula and habitat, in ABC Red Zones, and within migratory routes. These no-development zones can help delineate the covered land for the MSHCP's boundaries. Take of birds and bats should be avoided and minimized through appropriate siting, design, and operational measures. The MSHCP's mortality monitoring program and adaptive management provisions must be clearly defined, and any actions that are to be required of project developers in response to information gained through adaptive management or in response to changed circumstances must be fully specified.

With respect to the permitting structure of the MSHCP, the planning partners should be cognizant of USFWS's supervisory role and responsibilities under the ESA and implementing regulations. Additionally, under either proposed approach, the individual ITPs or Certificates of Inclusion should be tailored to incorporate site-specific and project-specific avoidance, minimization, and mitigation measures, and the planning partners need to develop a system for holding permittees accountable for noncompliance. Finally, looking forward to the next stages of the planning process, the MSHCP should evaluate the full range of potential effects due to issuing ITPs on a regional scale.

In closing, thank you for this opportunity to comment. The MSHCP could be a strong tool for facilitating both wildlife conservation and wind power, but it will require careful planning and implementation. We look forward to further participation in the planning process as it develops. Please add CLC and ABC to the notification list, using the names and contact information below.

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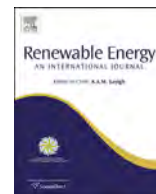
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ATTACHMENT B:

Kaoshan Dai et al., *Environmental Issues Associated with Wind Energy – A Review*, 75
RENEWABLE ENERGY 911 (2015)



Review

Environmental issues associated with wind energy – A review

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ARTICLE INFO

Article history:

Received 30 October 2013

Accepted 30 October 2014

Available online 19 November 2014

Keywords:

Wind energy

Environmental impact

Mitigation measure

Literature review

ABSTRACT

Recognized as one of the most mature renewable energy technologies, wind energy has been developing rapidly in recent years. Many countries have shown interest in utilizing wind power, but they are concerned about the environmental impacts of the wind farms. The continuous growth of the wind energy industry in many parts of the world, especially in some developing countries and ecologically vulnerable regions, necessitates a comprehensive understanding of wind farm induced environmental impacts. The environmental issues caused by wind farms were reviewed in this paper by summarizing existing studies. Available mitigation measures to minimize these adverse environmental impacts were discussed in this document. The intention of this paper is to provide state-of-the-art knowledge about environmental issues associated with wind energy development as well as strategies to mitigate environmental impacts to wind energy planners and developers.

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1. Introduction

Combustion of fossil fuels is believed to be one of the primary factors contributing to global warming. Energy researchers, industrial professionals, and government decision makers have increasingly turned their attention to renewable energy sources in an effort to reduce reliance on fossil fuels. Energy technologies such as biomass, wind, and geothermal are developing very fast and are becoming more commercially competitive [1]. According to the predictions of the European Renewable Energy Council, about half of the total global energy supplies will come from renewable energy in 2040 [2]. Johansson et al. [3] predicted that there would be a large increase in renewable energy production and efficiency before 2050. This increase of renewable energy use should lead to a substantial decrease of carbon dioxide emissions.

As one of the most mature renewable energy technologies, wind power has seen accelerated growth during the past decade. Wind power has become the preferred option of energy for planners and national governments, who are seeking to diversify energy resources, to reduce CO₂ emissions, to create new industries, and to provide new employment opportunities. According to the latest Global Wind Report, the total global wind power installation was 318.105 GW at the end of 2013 [4]. However, wind energy developments are not free of adverse environmental impacts. A poor understanding of these environmental impacts is a serious concern for the wind energy industry especially in developing countries and ecologically vulnerable regions [5,6].

In this paper, the authors reviewed potential environmental issues caused by wind farm developments, summarized evidence collected through existing case studies, and identified methodologies to mitigate these adverse environmental impacts. This review study provides energy industry planners and developers with an understanding about how an inappropriate wind farm project design could adversely affect a local environment. Mitigation efforts should be completed during the design, construction, and operation phases of a wind farm in order to avoid damages to vulnerable ecological systems.

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2. Wind energy induced environmental issues

A wind power plant uses wind turbines to convert wind energy into electricity or mechanical energy. The output power of a turbine is the function of the density of the air, the area swept by the turbine blades, and the cube of the wind speed [7]. The primary environmental issues related to wind turbine usage include wildlife safety, bio-system disturbance, noise, visual pollution, electromagnetic interference, and local climate change [8,9]. These issues can be grouped into ecological effects, impacts on humans, and climate-related issues [10,11].

2.1. Effects on animals

2.1.1. Birds

Wind turbines induce mortality and disturbance risks to birds. Birds can be killed by colliding with the rotating propellers of a wind turbine or can suffer lethal injuries because of collision with the turbine towers, nacelles or other structures in a wind farm such as guy cables, power lines, and meteorological masts [12]. Loss et al. [13] estimated that 234,000 birds on average were killed annually by collisions with monopole wind turbines in the U.S. Saidur et al. [5] reported that bird fatality rates at different regions of the U.S. average 2.3 birds per turbine per year for wind turbines with rotor diameters ranging from 33 m to 72 m. Although birds have been killed by pesticides or collisions with other human-made structures, including fossil fuel infrastructures [14], the adverse effects of wind farms on birds cannot be ignored. In addition, wind turbine towers were found to have killed birds from some rare species such as golden eagles, swans [15], and Cantabrian Capercaillies [16]. Because researchers used different methods to calculate the number of bird fatalities [17], it is unrealistic to compare the mortality numbers in these studies. The accurate bird fatality rate is difficult to estimate due to variations in search area, searcher efficiency and predator removal rates [18,19]. The number of fatal bird collisions varies by different locations. Even in the same location, differences still exist among different groups of wind turbines [20]. The wind turbine induced bird mortality data in publications are summarized in Table 1.

Various factors contribute to wind turbine induced bird mortality, such as the wind turbine design and arrangement, bird species, and climatic variables. Orloff and Flannery [21] reported that bird mortality was higher for lattice turbines than for other turbine tower types. The location and layout of the wind farm also have influence on the bird mortality rate. The approaching angle between the bird flight path and the turbine orientation showed a significant correlation with collision probability [22]. The end of turbine strings, the edge of the gap in the strings, and the wind turbine cluster's edges were the most dangerous places for birds [23]. The bird mortality rate increased in areas where turbines are located on ridges, on upwind slopes, or close to the bird migration

routes [24–26]. For example, if a wind farm is on a bird migratory route, birds have to avoid the wind farm and deviate from their usual route. The extra deviation work will increase the energy expenditure of the birds and reduce their survival rates [27,28]. This wind farm barrier effect on birds is species-specific. In fact, bird mortality was found to be associated with the bird species [29]. Orloff and Flannery [21] observed that golden eagles, red-tailed hawks, and American kestrels were killed more often than turkey vultures and ravens. This may be attributed to the foraging behaviors or flight characteristics of these birds. Desholm [30] used two indicators, the relative abundance and the demographic sensitivity, to characterize the sensitivity of the collisions of birds and wind turbines. Langston and Pullan [25] suggested considering diurnal and nocturnal phenomena as well to characterize the same problem because birds behave differently during these scenarios. Bad weather and light conditions, such as fog, rain, strong wind, or dark nights, can decrease the visibility and the flying height of birds. This may result in more collisions [12,25,26]. However, the correlation between the collisions and poor weather and light conditions has not yet been clearly identified because of the difficulty of observing birds in these conditions. Seasons are also a factor; Smallwood and Thelander [23] found that more bird fatalities occurred at wind turbines during the winter and summer months. Although there are many studies, the correlation between wind turbine induced bird mortality and many other variables such as turbine types and topographic features have not yet been established. Because there are so many complicated factors that contribute to the relationship between bird mortality and wind turbines, special efforts should be made when comparing data of different studies.

Another negative impact of wind turbines on birds is disturbance, which includes habitat destruction, the barrier effect, and impact on the bird breeding and feeding behavior. Construction of wind turbines and associated infrastructures may cause destruction of local birds' habitat [25,31]. Some wind turbines can also create physical barriers that obstruct birds from access to their natural feeding grounds and roosting locations. Noises and turbulent air currents produced by the wind turbines' operation may scare birds away and narrow their territories, which can also affect birds' foraging behavior. Construction of power lines and roads for wind farms may create other obstacles for birds. It was found that prairie birds tried to avoid power lines and road construction sites by at least 100 m [32]. Power lines and roads themselves may also cause extensive habitat fragmentation and provide an invasion path for exotic species [33]. Christensen et al. [34] studied birds' behaviors with radar tracking. He concluded that 14%–22% of the birds increased their flying altitude to pass through the studied wind farm. Additionally, the majority of the birds either changed their flying direction to bypass the wind farm by a distance of 400 m or 1000 m or completely disappeared from the radar screen [34]. Similar bird re-orientation behaviors were observed by Kahlert

Table 1
Bird collision mortality caused by wind turbines [18,29,150,151,152].

Bird mortality: /turbine/year	Location and time	Turbine information	Reference
24 birds	East dam, Zeebrugge (2001–2002)	200, 400, and 400 kW	[18]
35 birds	Boudewijn canal, Brugge (2001–2002)	600 kW	[18]
18 birds	Schelle (2002)	1.5 MW	[18]
0.27 birds	Straits of Gibraltar (1993/12–1994/12)	1.0–1.8 MW with the rotor diameter between 18 m and 23 m	[29]
0.03 birds	Tarifa, Spain (1994/7 to 1995/9)	66 turbines (total 10 MW) with 20 m diameter rotors	[150]
0.186 vultures	Tarifa, Cadiz, Spain (2006–2007)	296 turbines (0.3–2.2 MW) with rotor diameter 56–90 m	[20]
0.145 vultures	Tarifa, Cadiz, Spain (2008–2009)	296 turbines (0.3–2.2 MW) with rotor diameter 56–90 m	[20]
3.59 birds	Nine Canyon Wind Power Project (2002/9–2003/8)	37 1.3-MW turbines with approximately 62 m rotor diameter	[151]
1.33 birds	Tarifa, Andalusia, Spain (2005–2008)	252 turbines ((0.3–2.2 MW) with rotor diameter 56–90 m	[152]

et al. [35] in his study at the Nysted wind farm. Langston and Pullan [25] studied the impacts of wind farms on breeding, feeding and roosting behaviors of different bird species. The study reported that even though the wind turbine showed no impact on the bird population and distribution of Eurasian oystercatchers, northern lapwings, and common skylarks found within a one km range around the wind farm, negative effects on the birds' breeding, feeding, and roosting behaviors were observed for common redshank and black-tailed godwits within a 200-m range around the wind farm. Additionally, the feeding and roosting behaviors seem to be more sensitive than the breeding behavior [25]. Another research study found that, through 10 years of observation data on 47 eagle territories in western Norway, coastal wind farms affected the breeding success rate of the white-tail eagles [36].

2.1.2. Bats

Bats are more likely to respond to moving objects than stationary ones [37]. However, a high bat mortality rate close to wind farms has been observed. Wind turbine related bat mortalities are now affecting nearly a quarter of all bat species in the United States and Canada [38]. Research revealed that wind turbines killed not only bats from local populations but also migratory bats [39]. However, researchers are not in agreement about the reasons for the bat mortalities [40,41]. Early studies concluded that bats were killed by the sudden pressure drop near the turbine edges, which caused the bats to suffer barotrauma and internal hemorrhaging [42]. Barotrauma-related internal hemorrhaging was found in over 50% of the dead bats [43]. More recent research found that impact trauma was responsible for the majority of the turbine-associated bat deaths [44,45]. Other researchers proposed alternative explanations. According to Arnett et al. [46], bats could be attracted by the ultrasound emissions and the lights of the wind turbines. However, this hypothesis needs to be proven through further research. Another possibility is that the bats treated the wind turbines as trees and tried to explore them as potential roosting sites. In addition, a large amount of insects attracted by the high heat radiation of the wind turbine nacelles could also cause the hunting bats to aggregate around the turbines [47,48].

Kunz et al. [49] observed that a large number of dead bats were found at utility-scale wind energy facilities located along forested ridge tops, although bat carcass search is easier in grassland areas compared to agricultural landscapes or forested ridge tops. Marsh [15] indicated that the wind farms on the forested ridges were more dangerous for bats. Additionally, more bats were killed in autumn migration and during the two-hour period after sunset [15]. According to Kerns and Kerlinger [50], weather conditions and bat mortality do not seem to be directly associated. The bat fatality rate did not change when the wind speed was faster, when the environmental temperature was lower, or during foggy conditions. The flashing red aviation lights on the top of the wind turbine towers were not a reason for the bat mortality [51]. A study by Barclay et al. [52] showed that the size of the rotor was not associated with the death toll of bats, but the height of the turbine tower was. The bat mortality rate increased exponentially as tower height increased [52]. This brought up a new concern: future wind farms will have less wind turbines but each turbine will be higher; this may increase bat mortality. A comprehensive bibliography associated with the wind farm induced bat mortality rate up to 2008 can be found in Ref. [53].

2.1.3. Marine species

Offshore wind turbines may have impacts on marine species. Construction of wind turbine foundations and on-site erection of wind turbine towers make seawater turbid and introduce additional objects on the seabed, which may cause damages to the

benthic fauna and flora and may block sunshine in the water. Wind turbines and their scour protection may change the nearby fish distribution. Wind farm construction creates an artificial reef, which also impacts biodiversity. Research on two Danish wind farms [54] indicated that, around the foundation of the turbines, the abundance and diversity of the benthic communities increased more than the native infauna communities. Studies also showed that wind turbines built in seawater increased the fish populations considerably, possibly because of the enhanced resident food supplies on the turbines [55,56]. However, Berkenhagen et al. [57] believed that if the cumulative effect was considered, the offshore wind farms would induce a substantial effect on fisheries. In particular, the opportunities to catch valuable species would be considerably reduced. However, other studies indicated that, within a time window of seven years after construction, the studied offshore wind farm showed neither a direct benefit nor a definite threat to fish diversity [58] as well as sandeels and their sand habitat [59].

The noise and the electromagnetic fields around wind turbines may lead to negative effects on fish [60]. Marine mammals such as porpoises and seals may react to wind farms, especially during construction phase activities such as pile driving [54,61]. At the Nysted Offshore Wind Farm, researchers observed a clear porpoise population drop during construction and operation of the wind farm, which persisted for two years [54]. Wind turbine maintenance activities, such as parts replacement or lubrication, can cause oil or waste to enter and pollute the surrounding seawater. Although research results in literature [62] claimed that the potential impacts of wind farms on marine life were mainly within the construction phase and the impacts during the operational phase were more local, marine wind farms should be carefully planned to avoid major habitats of local sea animals.

2.2. Deforestation and soil erosion

During construction of a wind farm, some activities such as foundation excavation and road construction, may affect the local bio-system. If surface plants are removed, the surface soil would be exposed to strong wind and rainfall, resulting in soil erosion. Wastewater and oil from the construction site may seep into the ground soil and lead to serious environmental problems. Areas with rich wind resources, including grasslands, moorlands and semi-deserts, typically have weak eco-systems with low bio-diversity. Construction with heavy machinery may disturb the local eco-balance, and the local environment's recovery may take a long time. A Chinese wind turbine construction guideline [63] suggested that excavation should involve human labor as much as possible in order to minimize the disturbance induced by the heavy machines. In addition, the guideline recommends that trees and grasses should be replanted as soon as possible after construction.

2.3. Noise

Noise is one of the major environmental hindrances for the development of the wind power industry. According to Van den Berg [64], during quiet nights, people reacted strongly to the wind turbine noise in the range of 500 m surrounding the wind farm and experienced annoyance in the range of 1900 m surrounding the wind farm. It was also found that people were more annoyed by wind turbine noise than by transportation noise [65]. In addition, wind turbine induced visual and aesthetic impacts on the landscape could cause people to be more annoyed [65]. However, compared to the large quantity of data on transportation noise induced annoyance, studies on the correlation between annoyance and wind turbine noise are limited.

Two types of noise are produced by wind turbines: tonal and broadband noises. Tonal noise is defined by discrete frequencies (in the range of 20 Hz–100 Hz) and is generated by the non-aerodynamic instabilities and unstable airflows over holes, slits, or a blunt trailing edge of a wind turbine [66]. Broadband noise, a random, non-periodic signal with a frequency more than 100 Hz, contains continuous frequency distribution generated by the interaction of wind turbine blades with the atmospheric turbulence and by the airflow along the airfoil surface [66]. The noise of the wind turbines includes aerodynamic noise and mechanical noise. Aerodynamic noise comes from the turbine blades passing through the air. This noise, perpendicular to the blade rotation surface, varies with the turbine size, the wind speed, and the blade rotation speed. A strong wind with a big turbine is obviously noisier. Since modern turbines can rotate to face the wind upward direction, noises can come from different directions at different times. Some turbine blade pitches also can automatically adjust with the change of wind direction which produces different levels of noise. Aerodynamic noise contains different frequencies and is considered to be a broadband noise [67]. Mechanical noise comes from the turbine's internal gears, the generator, and other auxiliary parts [68]. These noises are noticeable and irritating, especially for wind turbines without sufficient insulation [67]. Contrary to the aerodynamic noise, mechanical noise does not increase with the turbine dimensions, and it can be controlled through proper insulation during manufacturing [69]. The total noise, measured by the sound pressure level dBA, is a combination of the mechanical and the aerodynamic noises. The low frequency noises (10–200 Hz) are considered as the substantial part of the noises when the modern turbines become larger [70].

Early acoustic noise testing was performed on several small-size wind turbines [71–77]. Recent studies on utility-scale wind turbines showed that the sound pressure level at 40 m away from a single turbine can vary from 50 to 60 dBA [78]. In a wind farm, the noise level at a certain distance from a group of wind turbines is also related to the number of turbines in operation. For example, the sound pressure level in a house located at 500 m away from a single wind turbine normally varies from 25 to 35 dBA. At the same distance, the noise level generated by 10 operating wind turbines can range from 35 dBA to 40 dBA [78].

Many other factors contribute to noise propagation and attenuation, including air temperature, humidity, barriers, reflections, and ground surface materials. For example, inside a building, the wind direction and the building material sound absorption ability have influence on the attenuation of the noise [67]. Another important factor is the background noise. At night, noises can be perceived differently. The whooshing (amplitude-modulated noise from wind turbines) can be perceived with increased intensity and can even become thumping. This is due to the ambient noise or background noise being low at night as a result of low human-made noise and the stable atmosphere [7]. According to Van den Berg [64], during an otherwise quiet night, a person living 1.5 km away from a wind farm perceives the wind turbine noise as an “endless train”. However, if the wind farm was located on the seashore, where background noises from the waves and the wind are loud, wind turbine induced noise cannot be differentiated from the ambient noise. Therefore, when analyzing wind turbine noise, the measured noise pressure level of wind turbines should be modified by the background noise.

To control the noise level, a minimum separation distance between wind farms and habitations is usually recommended by governments or medical institutions and varies among countries or regions, which are summarized in Table 2. Another approach to control the noise level is to set an upper limit dBA value that can be heard at the closest inhabited dwelling. Such restrictions for

different countries or regions are collected in Table 3. The L_{90} in Table 3 measures the noise level that is exceeded during 90% of the time, and it represents the noise level someone can hear in the late evening or at night when there is very little background noise [79]. L_{90} is useful because it minimizes the background noise effects that mask the noise of wind farms [80,81]. Kamperman and James [79] argued that using a single A-Weighted (dBA) noise descriptor, which approximates the response of human hearing to medium intensity sounds, is not adequate to limit the wind turbine noise that has significant low frequencies. To supplement the current standards, Kamperman and James [79] proposed to limit the C-Weighting (dBC) noise within $L_{90} + 20$ dB and 50 dBC maximum [79]. The C-Weighting approximates human hearing to loud sounds and can be used for low-frequency sound measurement.

Noise can induce sleep disturbance and hearing loss in humans. Exposure to high frequency noises can trigger headaches, irritability, and fatigue, as well as constrict arteries and weaken immune systems [82]. Disturbing noises can also induce negative subjective effects such as annoyance or dissatisfaction [81]. Shepherd et al. [83] conducted a questionnaire study on people who lived within 2 km of wind turbines. Results showed that the wind turbines affected life quality and amenity for some residents. Those residents were not willing to accept wind turbines and kept a virulent attitude against wind turbine projects. Other studies also showed

Table 2
Recommended distances between wind farms and habitations [143,144,145,146,147,148].

Region	Distance (m)	Reference
England (U.K.)	350	[143]
Scotland (U.K.)	2000	[143]
Wales (U.K.)	500	
Belgium	350 in theory (developers making it no closer than 500)	[144]
Denmark	4 × the total height	[144]
France	1500 (in practice 500 seems minimum observed)	[144]
Germany	Between 300 and 1500	[144]
Italy	Between 5 × the height or 20 × the height (not specified if mast or total height)	[144]
Netherlands	4 × the height of the mast	[144]
Northern Ireland	10 × rotor diameter (with a minimum distance of 500)	[144]
Romania	3 × height of the mast	[144]
Spain	Between 500 and 1000	[144]
Switzerland	300	[144]
Sweden	500 (in practice)	[144]
Western Australia	1000	[145]
Manitoba (Canada)	500–550	[146]
Ontario (Canada)	550	[145]
Prince Edward Island (Canada)	3 × the total height	[145]
Illinois (U.S.)	3 × the total height of the tower + the length of one blade	[147]
Kansas, Butler County (U.S.)	304.8	[147]
Kansas, Geary County (U.S.)	457.2	[147]
Massachusetts (U.S.)	1.5 × total height	[147]
Minnesota (U.S.)	At least 152.4 and sufficient distance to meet state noise standard	[147]
New York (U.S.)	1.5 × total height or 457.2 m	[147]
Oregon (U.S.)	1000	[145]
Door County, Wisconsin (U.S.)	2 × total height and no less than 304.8	[147]
Portland, Michigan (U.S.)	2 × total height and no less than 304.8	[145]
North Carolina (U.S.)	2.5 × total height	[145]
Dixmont, Maine (U.S.)	1609	[145]
China	200 for a single wind turbine, 500 for a large wind farm	[148]

Table 3
Noise limits in different regions [79,144,145,149].

Country/region	Noise limits	Reference
UK	40 dBA (day) and 43 dBA (night) or $L_{90} + 5$ dBA	[79]
Denmark	40 dBA	[79]
France	$L_{90} + 5$ dBA (day) and $L_{90} + 3$ dBA (night)	[79]
Germany	50 dBA (day) and 40 or 35 dBA (night)	[79]
Belgium	49 dBA (day) and 39 dBA (night)	[145]
Netherlands	40 dBA	[145]
Portugal	55 dBA (day) and 43 dBA (night)	[145]
Sweden	40 dBA	[145]
Holland	40 dBA	[79]
Australia	$L_{90} + 5$ dBA or 35 dBA	[79]
Oregon (U.S.)	36 dBA	[145]
New York (U.S.)	50 dBA	[145]
North Carolina (U.S.)	55 dBA	[145]
Maine (U.S.)	55 dBA (day) and 45 dBA (night)	[145]
Illinois (U.S.)	Octave frequency band limits about 50 dBA (day) and 46 dBA (night)	[79]
Wisconsin (U.S.)	50 dBA	[79]
Michigan (U.S.)	55 dBA	[79]
Ontario (Canada)	45 dBA (in urban and suburban areas) and 40 dBA (in rural areas)	[144]
British Columbia (Canada)	40 dBA	[145]
Alberta (Canada)	50 dBA (day) and 40 dBA (night)	[145]
Québec (Canada)	40 dBA	[145]
China	55 dBA (day) and 45 dBA (night)	[149]

that sleep deprivation due to the wind turbine noise can cause serious health problems. However, studies have not yet proved that these noise *per se* directly cause health problems or that the infrasound from the wind turbines directly impacts the vestibular system [7]. Due to the paucity of literature and the fact that annoyance can be caused by many other factors, more rigorous studies are needed to find a clear association between annoyance and wind turbine noise.

2.4. Visual impact

Shadow flicker, an effect caused by the movement of the turbine blades through the sunshine, becomes a human impact when a number of parameters converge, including distance from turbine, operational hours, and interactions with the sunlight [84]. Besides the flickering shadows, the negative visual impact of wind farms on landscapes is another factor that makes people have a negative opinion of the wind energy industry [85]. A study by Bishop [86] revealed that during days with clear skies, wind turbine towers can be seen from as far as 30 km. With the trend of constructing new wind turbine towers that are taller than their predecessors [87], the visual impact problems of the wind turbines cannot be ignored anymore. However, this problem is subjective. People's positive or negative attitude may depend on their perception on the unity of the environment, their personal feeling towards the effects of wind turbines on the landscape, and their general attitude about the wind energy industry [88]. Some may consider wind energy as a useful alternative to reduce the conventional energy induced negative consequences on the environment while others may look at the wind turbines as machines that are changing a beautiful landscape into an industrial environment [89].

Evaluating the visual impact of a wind farm is a difficult task [90]. Thayer and Freeman [89] implemented a subjective study using a survey. The result showed that a wind farm has more impact on those people who live close to it and who are more familiar with the original landscape. Most people prefer to see wind turbines that are neutral toned, larger in size but small in utility

quantity. Other surveys showed that the public usually supports wind power and the renewable energy industry [91]. However, most local residents may oppose construction of a new wind farm close to them, even though they know it will benefit the society. This neighborhood opposition to construction projects is the so-called Not-In-My-Back-Yard syndrome (NIMBY) [91,92]. The basic concept of the NIMBY syndrome is that people tend to support wind energy at a conceptual level, but concerns about unfavorable effects from wind farms cause people to be opposed to the implementation of local wind farm projects. However, the NIMBY syndrome, which has been widely used to explain public opposition to wind farms, was questioned by some scholars. Ek [93] found that people who are more interested in environmental issues are more likely to have a positive attitude towards a wind energy project. Erp [94] concluded that the attitudes of the developer, the local decision makers, and the decision processors have significant influence on public attitude towards a wind energy project. However, aesthetic concerns about wind turbines are legitimate and concrete. Torres-Sibille et al. [95] used an objective method to study the aesthetic impacts of wind farms. To measure wind farm induced visual impacts on landscapes, they developed an indicator that involved the visibility, the color, the fractality, and the continuity of a wind farm.

Factors influencing the intensity of visual impacts of wind turbines include scenic backgrounds, local topographies, and local landscapes between viewers and turbines [90]. When idle, a wind turbine looks like an abandoned machine. If a wind turbine is located near a scenic spot or an archaeological area, people are more likely to view the turbine as visual pollution. If a wind turbine is built in narrow or closed areas such as valleys, its visual impact appears to be more intensive [90]. A wind turbine located on a hill may induce direct visual impact, but intensity can be weakened when viewing from a higher elevated position [96]. Therefore during the selection of the site for a wind farm, areas with high perceived scenic quality, especially on the coast, should be avoided. A simulation study conducted by Bishop and Miller [97] showed that in all weather and visibility conditions, the visual impact intensity of wind turbines decreases when viewed from a greater distance. The study also showed that wind turbines have less intense negative visual effects when their blades are moving. Hurtado et al. [98] employed a 3D model to study the visual impact of wind farms on surrounding villages. The number of blades and the blade rotating directions of a wind turbine can influence its visual impact. According to Sun et al. [78], a wind turbine with three blades is more acceptable to people who are sensitive to visual impacts than the one with two blades. The reason could be that the turbines with three blades tend to give a stronger sense of balance. Wind turbines with counter-clockwise rotating blades generated stronger visual disturbance to viewers [78]. The wind turbine layout in a farm can be categorized into regular layout and irregular layout. Generally, the regular layout created a better sense of visual regularity and consistency than the irregular layout, which may lead to a sense of chaos. However, even with the regular layout such as a grid, the intensity of the visual impact may change as the viewer moves across the landscape and observes the turbines from different directions and elevations [99].

2.5. Reception of radio waves and weather radar

Although the electromagnetic field of a wind turbine itself is extremely weak and is confined in a small range [90], it can still create electromagnetic interferences. Bacon [100] found three degradation mechanisms that can interfere with waves: the near-field effects, the diffraction effects, and the reflection or scattering effects. Studies carried out by Randhawa and Rudd [101] showed

that the diffraction in the Fresnel zone and the reflection or scattering effects created by wind turbines are the main mechanisms which degrade the radio performance. Wind turbine towers and blades can be an obstacle and can cause interference for wireless services. Wind turbine blades modulate radio wave signals strongly enough to affect many electromagnetic systems such as televisions, FM broadcast radios, microwave communication systems, and navigational systems [102]. This interference can induce ghosting effects (also named video distortion), which are pale shadows on a television screen. Interference also can cause errors in navigational systems and disrupt the modulation in typical microwaves. Wind turbines sometimes can create a shadow zone that blocks waves emitted from a transmitter [103]. They can also induce a diffraction effect with a predictable interference pattern around the turbine towers [101]. In addition, wind turbine towers sometimes can reflect radio waves because of reflective materials used on the towers. For instance, steel tubes for the turbine towers are good reflectors [103]. However, the blades of more recently constructed wind turbines are exclusively made of synthetic materials, which have minimized the impact on the transmission of electromagnetic radiation [90].

2.6. Climate change

Different studies have shown that wind turbines can impact local weather and regional climate. Zhou et al. [104] studied eight-year satellite data in regions of west-central Texas equipped with 2358 wind turbines and reported a temperature increase of 0.724 °C in the area. The study also showed that at night, the temperature increase was even more obvious. Wang and Prinn [105] demonstrated that, if 10% of global energy demand came from wind power in 2100, the global temperature would increase by 1 °C. Wind farms may also change the global distribution of rainfall and clouds. However, this warming effect caused by wind turbines is still much weaker than that generated by the emission of greenhouse gases on the global scale.

Research indicated that the recovery rate of the wind speed, after the wind passed through a wind farm, is a decreasing curve [106]. A modeling study showed that the impact of wind farms on the wind speed at the hub height was noticeable for at least 10 km along the downwind direction. This may be because of the extra roughness induced by wind farms [107]. The turbulence created by wind turbine blade rotations can affect the regional climate as well. Roy and Traitor [108] believed that the cooling effects during daytime and the warming effects at night for large wind farms are the direct results of the vertical air mixture near the ground surface. In a stable atmosphere where a warm air layer overlies a cool air layer, the vertical mixing can blow the warm air down and the cold air up, leading to a warm ground surface. On the other hand, in an unstable atmosphere with a negative lapse rate, the vertical mixing can push the cool air down and the warm air up, resulting in a cooling effect near the ground surface [108]. Therefore, wind farms altered the regional climate. This regional climate change can induce a long-term impact on wildlife and regional weather patterns.

In contrast, some other studies reported that wind farms were able to alleviate adverse climates, even though the effect was very limited [109]. Studies have found that the wind farms in Gansu Province of China were effective in decreasing the local wind speed and mitigated the hazards of sand storms [110]. Therefore, some researchers are studying the possibility of implementing intentional weather modifications by building giant wind farms [111].

Different analytical methods and models, such as the Blade Element Momentum model, the vortex wake method, and the computational fluid dynamics methods have been proposed for wind farm climate studies [112]. Barrie and Kirk-Davidoff [113] used

the General Circulation Model to simulate wind farms as distributed surface roughness elements. Their analysis results showed that some atmospheric anomalies at the wind farm were the result of decreased wind speeds. Those anomalies grew quickly, along the downstream direction, in various forms of baroclinic and barotropic modes. Fiedler and Bukovsky [111] conducted a simulation study, using the nested regional climate model, on the effects of a giant wind farm on warm season precipitation in the eastern two-thirds territory of the U.S. This study used increased wind drag at the rotor height and the turbulent kinetic energy to parameterize the presence of wind farms rather than simply enhancing the ground surface roughness. A 1% increase in precipitation in 62 warm seasons was observed as the result of the presence of wind farms.

3. Mitigation of wind energy environmental risks

Wind farms may generate various environmental issues as reviewed in aforementioned literature. Those issues should be considered during the design and development phases of wind farms. Recent publications have explored public concerns about the negative effects of wind turbines [9,11]. Mitigation strategies are discussed in the following sections in order to involve more researchers and engineers in this campaign.

3.1. Limiting the effects on birds and bats

To reduce bird fatalities, several strategies could be considered. Restricting construction activities to non-breeding periods could help reduce the negative effects of bird disturbance [114]. Structural design improvements were also effective in reducing bird mortality [115]. For example, enlarging the blades and slowing the rotational speed of wind turbines can lower the bird fatality rate. The impact of wind turbines on birds' vision is one of the reasons why birds collide with turbine towers. McIsaac [116] found that the pattern-painted blades could increase the visual acuity of raptors. Blades can be more visible with night illuminations [15]. However, there are different opinions on what impact this solution would have. According to Langston and Pullan [25], the lights on turbine towers may attract birds, especially in bad weather conditions, and increase the chance of collision. However, Arnett et al. [46] found no difference in bird or bat fatalities at wind turbines, whether lit or not. A wind turbine that can automatically stop when birds approach could be very effective. De Lucas et al. [20] tested this idea, and the results showed that bird mortality decreased by 50% in a year while sacrificing energy production by 0.07%. Turbine design optimization is another effective way to reduce bat mortality [117,118]. Long et al. [119] proposed a methodology based on fundamental analytical models that optimizes turbine designs in order to maximize the chances of bats being able to detect the presence of the blades.

Site selection of a wind farm is also important [26]. The monitoring and modeling methodology proposed by Liechti et al. [120] is an effective approach to select a suitable location. The methodology suggested building wind farms far from important bird habitats and bird migration routes. It is helpful to work with ornithologists to consider possible impacts on birds when designing a wind farm layout. Bird flight activities in a zone of 200–500 m surrounding the planned wind farm should be recorded and analyzed [27]. Flight heights, directions, species, and behaviors of birds should be studied systematically. Sensitivity analyses are also helpful when selecting a wind farm location [121]. Clarke [122] pointed out that wind farms should be located at least 300 m away from any nature conservation site. Spatial distribution and aggregation activities of vulnerable species should be assessed before a wind farm construction in order to minimize bird disturbances [123]. After wind

turbine locations are finalized, the direction of tower layout should be properly designed to reduce the effects on bird migration [124].

A suitable wind farm design is a comprehensive project [125]. Computer modeling and novel mapping techniques could be used to track the birds' migration routes when analyzing the potential effects of wind farms on bird conservation [27,126]. The spatial scale used in the modeling and mapping should be as large as possible [127]. Both short-term and cumulative impacts should be considered [128]. In addition to the computer modeling and mapping, field inspections and monitoring are also useful. Modern instruments such as video, radar, and acoustic and thermal imaging equipment have been successfully applied to study bat mortality under different weather conditions and in different landscapes [15]. Infra-red video cameras, as well as pressure and vibration sensors, have been integrated into automated recording systems to perform the environmental assessment of wind turbines and collect information on bird movements [12].

Northrup and Wittemyer [129] summarized the mitigation methodologies for the environmental impacts of wind turbines in their research. However, as Busch et al. [130] pointed out, in addition to the technical improvements, an international cooperative effort is important to reduce the environmental impacts due to global wind farm construction.

3.2. Reducing influence on marine environment and climate

To mitigate meteorological impacts of wind farms, the rotor-generated turbulences should be reduced [109]. Through improved rotor and blade designs and a proper design of turbine spacing and pattern, the turbulences can be mitigated, and the hydro-meteorological impacts can be reduced. It is also suggested to locate wind farms in regions where wind energy is abundant and the frictional dissipation is high. In this way, the wind energy will be harvested instead of losing as frictions. The purpose of this strategy is to increase the efficiency of wind farms [131].

Preliminary research showed that the noise caused by the offshore wind turbine operation could not be heard at 20 m below the water's surface [132]; studies also indicated that visual impacts of wind farms could be negligible at eight km away from the shore [132]. However, efforts are needed to further understand the influence of offshore wind turbines on the marine environment since the offshore wind farms are not always located far from the shoreline. With the increasing height of the wind turbine towers and the increasing size of the offshore wind farms, the environmental impacts of wind farms such as habitat fragmentations, noises, vibrations, electro-magnetic interferences, the impacts on fish, marine mammals and benthos are becoming significant. Therefore, the construction of offshore wind farms should be strictly managed to avoid ambient water pollution. Pile driving should not be conducted during the migrating seasons of porpoises to minimize disturbances. Through modeling and analysis, offshore wind farms should be spatially allocated to maximize revenues while protecting marine fish populations [133].

3.3. Noise reduction

To reduce noise from wind turbines, improved blade design is the key. A balance between the noise radiation and the energy production should be explored during the blade design phase [134]. An appropriate design of blades can significantly reduce the aerodynamic noise. The application of upwind turbines is also useful to reduce low frequency noise [135]. The insulations inside the turbine towers can effectively mitigate the mechanical noise during the course of operation [136]. The special gearboxes for wind turbines introduce less noise than standard industrial gearboxes. The

steel wheels of the special gearbox have semi-soft and flexible cores with hard surfaces to ensure strength, to extend the lifetime of the equipment, and to muffle noise [137]. Direct drive wind turbines without any gearbox or high-speed mechanical component can operate more quietly. Variable-speed turbines create less noise at low wind speeds than the constant-speed turbines [135]. Besides technical measures, another way to avoid noise-induced problems is to build wind farms close to noisy areas. For example, road traffic can mask wind turbine noise if the traffic noise exceeds the turbine noise by at least 20 dBA. This method is effective for fairly quiet wind turbines with 35–40 dBA noise level [138]. Different criteria on the noise levels and the standoff distances between wind farms and habitations have been provided by different countries or regions. Suitable criteria should be followed with a comprehensive consideration of specific local conditions for a wind farm development.

3.4. Mitigating visual impact

The planning guidelines from the Ireland Department of the Environment, Heritage and Local Government (DEHLG)[32] suggested four factors to limit a wind farm's visual impacts on landscapes during the design phase: (1) whether it is acceptable to change the landscape; (2) how visually dominant are the wind turbines on the landscape; (3) what is the relationship between aesthetics and the wind energy development; and (4) how important is the impact. The shadow flicker issue from wind turbines can also be predicted and avoided with an appropriate siting design of a wind farm.

To encourage local residents to have a positive perception of wind farms, public participation in the early stages of the planning and implementation of wind power projects are recommended, such as working together to seek solutions to the visual impact issues [88,93]. Early communication is crucial to avoid conflicts with the public [85]. Devine–Wright [139] suggested that a project should go beyond the NIMBY label and incorporate social and environmental psychological aspects. The 'backyard' motives are dominated by the feelings about equity and fairness rather than selfishness, and institutional factors can play a more important role than the public acceptance of wind power projects [85,140]. Involvement of local residents and good communication can help decrease the public resistance to wind energy projects.

Wind turbine tower layouts can be categorized as regular and irregular formats. Generally, the fewer the number of wind turbines and the simpler the layout, the easier it is to create a visually balanced, simple and consistent image. For regular landscapes such as an open or leveled space, a regular layout, such as a double line, a triangle, or a grid, is preferred. Irregular layouts are more suitable for the landscapes with variable elevations and patterns [141]. Selecting an appropriate color for a turbine is important to mitigate its visual impact. Rather than painting turbines in a color to camouflage them against their background, it is more suitable to choose a color to engage the turbines to the backdrops at different views and in different weather conditions [99]. White, off-white or light gray gives people a feeling of cleanliness and efficiency. Dark or metallic colors, typically for industrial elements, may not be suitable for wind turbines [31].

3.5. Reducing electromagnetic interference

In Greece, construction of wind farms within a certain distance of a telecommunication, radio, or television station is forbidden [136]. However, in other European countries, wind turbine towers are commonly used for the installation of antennas to improve communication services, such as mobile phone services [136]. With

regards to the compatibility and interference with telecommunications, Binopoulos and Haviaropoulos [136] argued that the electromagnetic radiation and interference of wind turbines are very limited. However, there are scenarios when the electromagnetic interference causes problems. For these situations, various measures can be used to minimize the problem. Blades made from synthetic materials, compared to steel blades, produced less interference. Wind farms could be planned and constructed at locations without blocking broadcast signals [90]. The installation of extra transmitter masts could also be a solution, with a little extra cost for investors [90]. In regions where the wind turbine induced electromagnetic interference already occurred, deflectors or repeaters could be installed to overcome the problems.

4. Conclusions

Renewable energy is one solution for the global energy problem. In addition, renewable energy has beneficial socioeconomic impacts such as diversifying the energy supply, increasing regional and rural development opportunities, and creating domestic industry and employment opportunities [142]. However, renewable energy can create environmental issues in a habitat or a community. Even though the environmental impact of wind turbines is still a controversial topic, the impact should not be ignored. Minor issues today may cause disastrous effects in the future when wind energy becomes one of the main energy sources. As shown in this review study, more scientific studies are needed on the potential impacts of wind farms on the environment. Wind energy exploitation and related infrastructure construction projects should be evaluated for the economic, social, environmental, biological, and ecological influences. Suitable measures should be implemented to mitigate the environmental issues caused by the infrastructure construction and facility operation of wind farms. Developers, planners, and government officials need to gather and communicate complete information with the public to ensure that the projects are developed in a way that avoids, minimizes, and mitigates environmental impacts.

The paper reviewed published information regarding the environmental impacts of the wind power industry and the potential mitigation measures. Based on the discussions, several observations are summarized as follows:

- (1) Various rates of bird and bat mortalities caused by the wind turbines have been reported in literature. Turbine types, the topographic feature of a wind farm, bird/bat species, climatic conditions, and many other variables affect the mortality rate. Although it is not clear how significantly offshore wind farms affect the marine environment, caution should be used when locating offshore wind turbines close to major habitats of local sea animals. Many countries still do not have specific bio-system protection standards against wind turbines. It is often the developer's responsibility to conduct the environmental impact study. Extensive research is still needed to fully understand the influences of wind farms on local biological systems.
- (2) Noise induced by wind turbine operation has been studied for many years, and several criteria have been published in different countries and regions. One reasonable approach to reduce the noise disturbance of wind turbines is to follow suitable noise limits and distance criteria developed from those scientific studies. However, compared to the rigorous researches on other noise sources, such as transportation noise, there is not enough solid data and quantitative scientific studies about wind farm noises. More research is

required to accumulate the knowledge of wind farm noises through field measurements and theoretical analyses.

- (3) The visual impact of wind farms on the landscape is a subjective issue. Social studies and technology improvements could be used to help solve the problems. Even though disagreement remains about the meteorological impact and the electromagnetic interference of wind farms among different studies, large-scale wind farms do generate problems for regional climate and communication services. Therefore, mitigation technologies and measures at different scales should be considered during the wind farm planning stage.

Acknowledgment

The authors would like to acknowledge the support offered by the following programs: Shanghai Key Lab for Urban Ecological Processes and Eco-Restoration (SHUES2011A04), National Natural Science Foundation of China (51208382), Specialized Research Fund for the Doctoral Program of Higher Education (20120072120001), Shanghai Science Foundation (12ZR1433500), Shanghai Pujiang Scholar (13PJ1407900), Shanghai Science and Technology Supported Program (13dz1203402), and the State Key Laboratory of Power Transmission Equipment & System Security and New Technology (2007DA10512711414). Special thanks are also given to Mr. Martin Espanol and Ms. Xiaoxiao Wu for their editorial work. The views, opinions, findings, and conclusions reflected in this publication are the responsibility of the authors only and do not represent the policy or position of any agency.

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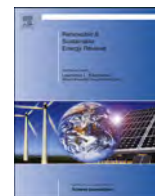
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ATTACHMENT C:

M. Premalatha Tabassum-Abbasi et al., *Wind Energy: Increasing Deployment, Rising Environmental Concerns*, 31 RENEWABLE AND SUSTAINABLE ENERGY REV. 270 (2014)



Wind energy: Increasing deployment, rising environmental concerns



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ARTICLE INFO

Article history:

Received 19 August 2013

Received in revised form

2 November 2013

Accepted 12 November 2013

Available online 18 December 2013

Keywords:

Wind energy

Wind turbines

Environmental impact

Global warming

Avifauna

Wildlife

ABSTRACT

Of all the renewable energy sources (RESs)—except direct solar heat and light—wind energy is believed to have the least adverse environmental impacts. It is also one of the RES which has become economically affordable much before several other RESs have. As a result, next to biomass (and excluding large hydro), wind energy is the RES being most extensively tapped by the world at present. Despite carrying the drawback of intermittency, wind energy has found favor due to its perceived twin virtues of relatively lesser production cost and environment-friendliness.

But with increasing use of turbines for harnessing wind energy, the adverse environmental impacts of this RES are increasingly coming to light. The present paper summarizes the current understanding of these impacts and assesses the challenges they are posing. One among the major hurdles has been the NYMBI (not in my backyard) syndrome due to which there is increasing emphasis on installing windfarms several kilometers offshore. But such moves have serious implications for marine life which is already under great stress due to impacts of overfishing, marine pollution, global warming, ozone hole and ocean acidification. Evidence is also emerging that the adverse impacts of wind power plants on wildlife, especially birds and bats, are likely to be much greater than is reflected in the hitherto reported figures of individuals killed per turbine. Likewise recent findings on the impact of noise and flicker generated by the wind turbines indicate that these can have traumatic impacts on individuals who have certain predispositions. But the greatest of emerging concerns is the likely impact of large wind farms on the weather, and possibly the climate. The prospects of wind energy are discussed in the backdrop of these and other rising environmental concerns.

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1. Introduction

1.1. The affordability and the perceived cleanness of wind energy

Wind energy is popularly perceived as one of the cleanest sources of energy. It is also the first of the renewable energy sources that has become 'affordable'—i.e. become capable of generating electricity at rates comparable with conventional energy sources (with or without subsidies).

Due to these twin advantages, wind energy is the most utilized of all renewable energy sources (RESs) for electricity generation today (if large hydropower is excluded from the consideration, which it generally is). Until 2007 Germany was leading the world as the biggest producer of wind-based power, followed by Spain and India (Fig. 1). In 2008 USA surged ahead, but only to be overtaken by China in 2010. Within Asia, India was the leader till 2007. But since then China has not just overtaken India but has zoomed so far ahead that it is now generating more than 3 times as much power from wind energy as India. With plans to start producing another 200 GW soon, China is expected to remain the world leader in the foreseeable future. India is now the fifth biggest producer of wind-based power in the world, with an installed capacity of 17.4 GW at present.

But these figures are impressive only when we compare wind energy with other RESs. If we look at the overall global energy scenario the perspective is very different. Wind energy meets a mere 0.2% to the total global energy demand and just 1.8% of all the world's electricity is being generated by wind energy [78,113]. This picture will change soon because of strong initiatives across the world to enhance the utilization of wind power for electricity generation. The main impetus for this comes from the urgency to control global warming by replacing coal-based and other fossil fuel-based energy generation with RESs [8]. Wind energy being, at present, the most affordable and apparently most clean of all other known RESs, is being expected to lead the shift from fossil fuels to RES.

1.2. The increasing deployment of wind energy

The Inter-governmental Panel on Climate Change (IPCC) in its recent report [47] has hoped that more than 20% of the world's electricity demand would be met by wind energy by the year 2050. The USA aims to reach this goal much earlier—by 2030 [241]. The "20-20-20" target set by the European Union [29] which aims at reducing greenhouse gases by 20%, reduces primary energy use by 20%, and enhances the contribution of renewable sources to meet 20% of the EU's energy demand by the year 2020, also aims to rely heavily on wind energy for meeting the first and the third of its targets [27]. Unless China surrenders its position as the world's biggest producer of wind-based electricity, it would also be soon meeting 20% or more of its power needs with wind energy. The Indian government has equally ambitious plans to enhance its wind power generation capacity [174,220]. Other countries are bracing to follow suit [211,218,236].

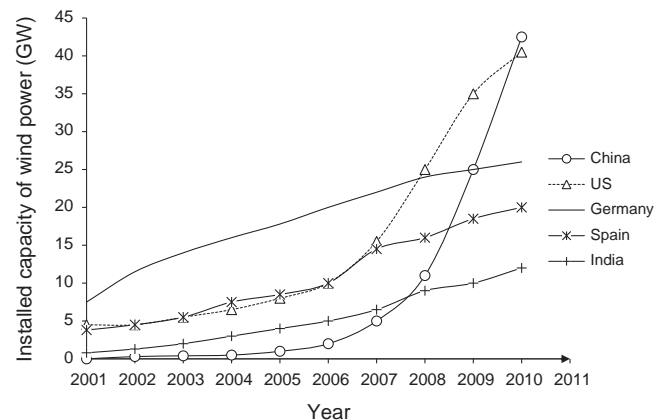


Fig. 1. Wind power generation by the world's top five wind energy harvesters (adapted from Ref. [151]).

At the present estimates the global electricity demand will be 8.5 TW by 2050 (Fig. 2). If 20% of it is to be met with wind energy this means that by 2050 the world needs to produce 50 times more power from wind energy than it is doing today! In other words in every coming year the world must add more capacity for wind electricity generation than the sum-total of the wind power capacity it has developed so far. The growth has to be still more brisk in the USA and the EU in order to meet their more ambitious targets. Seen in another light, Fig. 2 reveals that even as electricity demand would approximately double from its present value by 2050, to meet 20% of this demand from wind energy, the capacity of the latter must increase 50 times by 2050.

Will such a large-scale deployment of wind energy be free from adverse environmental impacts? Or will it cause only minor impacts that would be easy to reverse or manage? The world is planning to make equally significant shifts to other renewable energy sources in its attempt to replace fossil fuels by renewables [3–8]. If the solar thermal, solar photovoltaic, biomass, geothermal, small hydro, wave, tide, and ocean thermal energy systems are all developed to the extent the world is hoping to, will the impacts be still minor?

This paper aims to address these questions.

1.3. Changing perception

Till the beginning of the 1980s there were very few wind turbines in the world. At that time wind energy was thought to be totally 'clean' and totally free from any adverse environmental impact [1,2]. The popular perception was that all one would need would be to install a wind turbine on the roof of one's house and that would ensure supply of clean energy for the house throughout the year.

About 22 years have since passed. By now several wind farms have been installed in different parts of the world. The wind energy based power generation which was just 2.4 GW in 1990 has grown 122 times by now to about 295 GW (Fig. 3).

Even though, as said earlier, by now just 0.2% of global energy demand is being met by wind energy, those who are associated with wind energy no longer call it a "totally clean source of energy with no adverse impacts". This is because several adverse impacts have come to the fore now, and more are emerging as ever larger wind turbines are being installed and ever bigger wind farms are being set up in different parts of the world.

An increase in the use of wind energy from generating a couple of GW to a few hundred GW has brought a change in perception from it being 'non-polluting' to 'less-polluting'. It appears

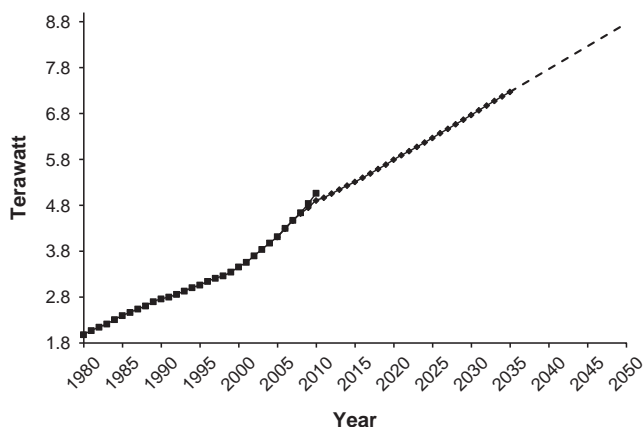


Fig. 2. Global electricity generation—past and future. The curve for the years 1980–2010 provides historic data for the electricity installed in that period. The curve for the years 2010–2035 is based on the forecast of the United States Energy Information Administration [242]. The curve spanning 2035–2050 is a linear extrapolation of the USEIA forecast.

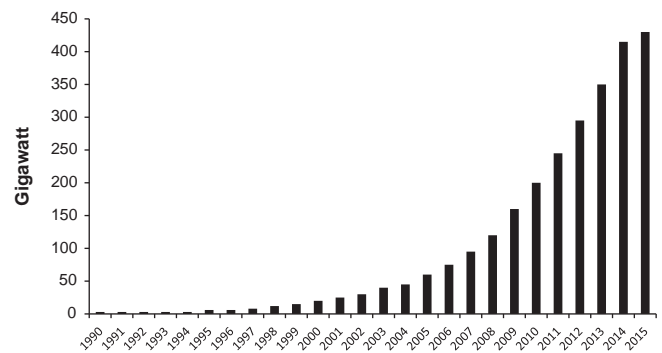


Fig. 3. Growth in the global wind power installed capacity upto 2012 and forecasts for 2013–2015.

reasonable to draw from this wisdom of hindsight and forecast the situation when several thousand GW of power will be generated with wind energy.

2. A brief history of wind energy

2.1. Use of wind energy down the ages

It is safe to assume that the use of natural breeze to dry and cool the body, with or without the aid of passive solar energy (sunlight), was the earliest form of the use of wind energy by the humankind. Much later, when humankind had learnt to make boats it began using wind energy for transportation on water by harnessing the wind's kinetic energy with the help of sails. Indeed for several thousand years wind was used as a source of transportation energy in this manner [9]; the speed and the direction of the boats and the ships were controlled by the number and the orientation of their sails.

Some 3000 years ago humankind invented windmills [105,116]. The earliest recorded windmills had vertical-axis and were used in the Afghan highlands to grind grain since the seventh century BC. The first windmills had sails similar to those on a boat. The sails were fixed to a vertical-axis wheel that turned horizontally. Those windmills were built inside towers with slots through which wind blew on the sails, moving the wheel. The grindstones attached to the wheel moved as the wheel moved, enabling the grinding of the grain [18]. The horizontal-axis windmills came much later; their first details are found in historical documents from Persia, Tibet and China at about 1000 AD [134]. This windmill type which is familiar to us, and which is the fore-runner of the present day wind turbines, has a horizontal shaft and blades (or sails) revolving in the vertical plane. From Persia and the Middle-East, the horizontal-axis windmill spread across the Mediterranean countries and central Europe. The first such windmill appeared in England around 1150 [11]. France, Belgium, Germany, Denmark, and other European countries followed suit in building windmills. From then till the 19th century, windmill technology was constantly improved across the world. By 1800, about 20,000 windmills were in operation in France. In the Netherlands, 90% of the power used in industry was from wind energy. These windmills were, typically, 30 m tall and used rotors of about 25 m diameter. The emergence of fossil fuels caused a decline but even in 1904 wind energy provided 11% of the Dutch industry energy requirements and Germany had more than 18,000 units [11].

In the initial decades of the 20th century, windmills slowly started to disappear in Europe, but they began to show up in North America, as the European immigrants installed small windmills for pumping water for livestock, especially in areas which, in those days, were not supported by the electricity grid. Those windmills,

also known as American Windmills, operated fully self-regulated, hence they could be left unattended. The self-regulating mechanism pointed the rotor windward during high wind speeds [105,116,207]. The European style windmills usually had to be turned out of the wind or the sailing blades had to be rolled-up during extreme wind speeds, to avoid damage to the windmill. The popularity of windmills in the USA reached its peak between 1920 and 1930 with about 600,000 units installed.

2.2. Electricity from wind energy

During the 1880s a British inventor James Blyth and an American inventor Charles Brush, working independently and without the knowledge of each other, made the first demonstrations of generating electricity from windmills. Perhaps the British inventor predated his American counterpart by a few months [201], generating electricity from a windmill in July 1887 [38]. Blyth used the electricity to charge batteries for his household lighting, but also offered surplus electricity to the people of Marykirk for lighting the main street. Interestingly, the villagers turned down the offer, as they thought electricity to be the work of the devil [15,161]! Blyth did manage to install a wind machine to supply emergency power to the local Lunatic Asylum, Infirmary & Dispensary.

In 1891, Poul LaCour built a wind turbine for generating electricity in Denmark. Danish engineers improved the technology during World Wars I and II and used the technology to overcome energy shortages during the wars. The wind turbines built by the Danish company F.L. Smidth in 1941–1942 were the first to use modern airfoils, based on the advancing knowledge of aerodynamics at that time. During the same years Palmer Putnam built a giant wind turbine, which was much larger than the other wind turbines of that era, for the American company Morgan Smith. It had a diameter of 53 m. Not only was the size of this machine significantly different from the Danish windmills, but so was the design. While the Danish windmill was based on an upwind rotor with stall regulation, operating at slow speed, Putnam's windmill had a downwind rotor with a variable pitch regulation [11].

Despite these and other advances which led to increasingly efficient turbines, the interest in large-scale wind power generation declined after World War II as the world preferred the more convenient, efficient, and reliable fossil fuels for all its energy needs. Only small-scale wind turbines, for remote area power systems or for battery charging, remained in use. The 'oil shocks' of 1973 and 1979 revived interest in renewable energy sources, including wind energy, but the enthusiasm slacked with the gradual easing of the oil crisis through the late 1980s to the end

of the 20th century. Then, as global warming became an increasingly accepted reality in the early years of the present century there has been a very strong revival of interest in wind energy. The revival seems to be for good this time [9].

3. Environmental impacts of inland wind farms

The drone of a moving wind turbine, especially when it seemed to pierce the silence of a night, was the first adverse environmental impact of wind energy that had surfaced. The next to emerge and gain prominence was the visual impact—perception of wind turbines adversely effecting the scenery [33,106,233]. The few murmurs of protest that were heard *vis a vis* noise-related disturbance were joined with louder protests and citizen's movements against siting of wind parks in one or the other region on the grounds that it tarnished the otherwise esthetically pleasing looks of a place. The third major impact to draw attention has been harm to birds and bats which get maimed or killed in flight when they run into wind turbines [70,71,110]. Interference with television transmissions and distraction caused by flickering shadows of moving turbines have been other objectionable consequences of wind power generation. Now the most shocking of the adverse impacts is coming in view—on the climate [254,267]. It was being feared since 2004 on the basis of theoretical studies but now concrete evidence is emerging that large wind farms can influence local weather but are also likely to influence the climate and can bring in significant changes in it.

What is the nature of each of these impacts and how serious each has been? To what extent attempts to mitigate them have succeeded or have the potential to succeed? What shape each of these aspects is likely to take as the world moves into the future with the expectation to generate 20% of its power from winds in the coming years?

3.1. Visual impact

3.1.1. The NIMBY syndrome and the efforts to fathom it

There has been a strange dichotomy associated with public acceptance of wind energy [178]. An overwhelmingly large majority perceives wind energy as highly benign and desirable ([86,118,177,231]) but most who favor wind energy do not favor wind turbines to be located near them [69,269]. Many prefer not to have wind turbines wherever they happen to go often enough. As wind turbines are made larger and larger (Fig. 4) to make them more economical and to reduce their carbon footprint per unit energy generated [48], their dominance on landscapes and the extent of their visibility is also proportionately

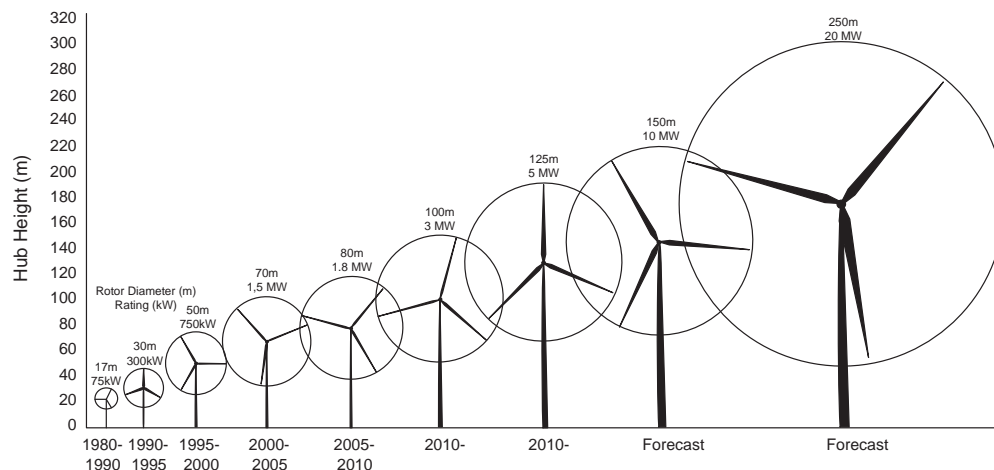


Fig. 4. Growth in size of commercial wind turbines (adapted from Ref. [113]).

increasing. With it is increasing public resistance to the installation of wind turbines within viewing distance [97,142,143,156,269].

Enormous research has been done, and is continuing to be done, to break the prevalence of this NIMBY (not in my back yard) syndrome. The research has aimed at finding the esthetic, socio-economic, political, and behavioral reasons behind the NIMBY syndrome with the aim to find ways around it. An early study by Bergsjö et al. [34] identified four scales of visual influence of a wind turbine:

- a sweep zone, defined by the radius of the rotor blade;
- a visual intrusion zone in which a unit is perceived as visually intrusive; it is about 5 times the total height of the unit;
- a visual dominance zone bounded by the maximum distance at which the turbine tower dominates the field of vision; it is about 10 times the height and
- a visibility zone inside which the unit can be seen easily but is perceived as belonging to the distant landscape (extends to about 400 times the height of the unit).

Bergsjö et al. [34] further observed that when many turbines are grouped or repeated as elements in the landscape, these zones become even larger. It is this high level of visibility and the sense of intrusion on the surrounding landscape that invokes strong opposition for wind parks.

The other factor that distinguishes wind turbines' visual impact is their stark visual expression of function: the turbines provide immediate, direct, evidence to the public whether they are operating or not. When arrays of wind turbines are all turning, the viewer receives an immediate evidence of their usefulness. On the contrary when significant numbers of turbines are idle it generates feelings of belied expectation [233].

Various other types of symbolic or connotative meanings are attached by different individuals or communities to wind turbines existing in different situations and in different contexts. The nature of such reactions differs from culture to culture, as also within a community if some individuals are benefitted by the turbines while some others are not. Attitudes also differ; beholders may view a wind farm positively if they consider the development to be appropriate, efficient, safe and natural (in the production of energy), progressive and a sign of the future. On the other hand, for subjects with negative attitudes wind turbines represent visual conspicuousness, clutter and unattractiveness. In a study by Ferber [83], in which reactions to different photographic simulations were obtained, each visual showing a different windmill in the same landscape setting, only a traditional Dutch windmill was considered to be a positive addition to the landscape by the majority of the subjects. All other modern turbines were judged to have neutral or negative impact. One simulation showing a row of seven modern wind turbines was rated only slightly less negatively than an ordinary powerline.

3.1.2. Tools to determine the degree of acceptability of wind turbines

Visualization tools to assess the degree of acceptability of different turbine sizes, turbine densities, turbine arrays, and turbine color schemes in a given location have been developed. For example Miller et al. [172] have formulated an interactive visualization procedure for illustrating the visual effect of turbines from different positions and also moving them about interactively in virtual space to help create patterns of turbine arrays that may be acceptable to the viewer. Lange and Hehl-Lange [144] have also used visualization as a tool to help allay community concerns and arrive at preferred design options. Álvarez-Farizo and Hanley [16] have used image manipulation and conjoint analysis in an attempt to quantify the social costs of wind farm development. Based on simple distance functions,

without visibility assessment, Baban and Parry [24] have used GIS to map site suitability by integrating wind resource utilization with avoidance of populated or visually sensitive areas.

It has been understood since long that the rate of impact decline is affected by factors such as the nature of the background, the local landscape and the landscape between the viewer and the turbines. These are particularly relevant for on-shore turbines that occur in a variety of visual contexts and possess a variety of visual absorption capacities [17]. Off-shore facilities are much less influenced by these considerations, yet off-shore proposals are also meeting with objections on visual grounds [37].

It has been argued [36,219] that contrast between the turbines and their background of sky is important and needs to be quantified. But atmospheric patterns are ephemeral and the sky-turbine contrast can change within weeks or days, sometimes within hours. Nevertheless in locations such as the ones which have a large number of clear days or a large number of foggy days, with relatively long-lasting weather patterns, color schemes can be devised which can reduce turbine-skyline contrast for as longer duration in an annual cycle as possible.

Attempts have also been made at quantifying and ranking visual impact, which include the so-called Quechee Test [184] and the Spanish method [111]; other multi-criteria impact evaluation frameworks [91,237]; perceptions modeling [142]; and quantifying the intensity of sensory perception [114].

The discussion in the preceding paras indicate that sincere efforts have been done since over 35 years to minimize or eliminate public opposition to wind turbines on account of the latter's visual impact. But all these efforts have been stymied by the unsurmountable challenge one faces when trying to quantify esthetics. It is an exercise no more easy than grading *objects d'art* on scales of excellence or developing a model which can prove whether Da Vinci was a greater painter or Picasso. The classical adage *beauty lies in the eyes of the beholder* is operative with the added dimension of presence or absence of self-interest. If a thermal power plant can be dismantled and a wind farm put in its place which could generate equivalent amounts of power, such wind farms will have near-universal acceptability. Wind farms on degraded or denuded lands, well away from residential localities, will also be generally welcome. But situations like this which *also* possess high wind energy potential are rare to find. In other situations the acceptability of wind turbines is more equivocal, giving rise to the challenge of finding the trade-off.

3.1.3. A few rules-of-thumb

Despite the impossibility of quantifying esthetics, a few broad aspects that contribute to the acceptability or otherwise of wind farms have been identified:

Perception of usefulness: as said earlier, if a wind farm replaces a more disagreeable source of power, it will have a high degree of acceptability. Even otherwise a wind farm which is functional for large parts of an year, delivering power when it is needed the most, is likely to be popular. On the contrary, when the majority of the wind turbines in a wind farm are standing still (due to lack of wind) at times like on peak summer or winter when electric power is needed the most, it generates the negative perception of a 'dead weight', a kind of trickery.

Perception of intrusiveness: depending on the nature of terrain and local geography different perspectives of size can result from wind farms of identical turbine size, number, and specing. For example a wind park installed on vast flat lands would appear smaller than a farm of identical size located at the top of a hill in a small island. The latter will appear more intrusive and overpowering than the former. In general, the visual impact of a wind farm on a landscape is much greater in narrow and closed

formations than in open areas. In the like manner a wind farm near areas of tourist attraction, especially ones related to heritage, would appear particularly intrusive. Likewise installation of a wind farm in the neighborhood of areas with remarkable natural beauty is deeply resented.

The visual impact of a wind turbine is dampened as one goes away from it [37]. The impact remains significant upto distances which are within 10 times the wind tower's height. Inside an area of this radius, the wind turbines begin to dominate the landscape. In clear weather, a turbine may be visible at distances upto to 400 times its tower height. This means that a wind turbine with a tower of 50 m height may be visible at distances of 20 km.

Perception tainted by self-interest or a lack of it: those who derive economic benefit from a wind power project have a very high degree of acceptability for it in contrast to those who are not benefitted.

Apart from the aspect of visual integration with the landscape, a color scheme associated with a wind farm can enhance or diminish its looks. It is generally accepted that the use of tubular towers rather than lattice ones improves the presentability of a wind farm. Another contributing factor is the visual symmetry and the grace of form associated with each turbine. How the color of the turbine's blades and the tower blends with the background can also influence the visual appeal (or the lack of it) of a wind park [156,237].

3.1.4. Public preferences versus economics of scale

Several studies have brought out that smaller wind farms are more positively perceived in comparison with larger-scale developments [69]. Lee et al. [150] refer to a 'favourability gradient' in noting a negative linear relationship between wind farm size and public support. The support was highest for wind farms in the UK with less than eight turbines. This finding has been replicated in several other countries. Research in Denmark [62] reported that clusters of two to eight turbines received more public support than both scattered single turbines and larger arrays. This finding was consistent across gender and age groups in this large-scale, representative Danish sample. From the Netherlands, Wolsink [266] has reported that wind farm developments were less highly supported than stand-alone turbines in a review of 11 empirical studies. In Ireland, too, [230] there is a preference for smaller, clustered groups of turbines over larger-scale installations; smaller numbers of large turbines are considered preferable to larger numbers of smaller turbines.

The public preferences reflected above are in direct conflict with the interest of wind power developers for whom larger-sized turbines and bigger wind farms represent increasing benefit due to increasingly favorable economics of scale. Large-sized turbines and bigger wind farms are also required to extract maximum benefit from favorable locations which, otherwise, will be used to much below their potential.

3.1.5. The portents

Other public preference revealed by more than one surveys is for the 3-blade turbines over 2-blade ones as the former appear more symmetrical [240].

From the foregoing it is clear that visual impact of wind farms will become an increasingly pressing issue as their number increases. With competition for uninhabited spaces increasing due to the needs of other space-consuming renewable-based power generation systems such as solar thermal/solar photovoltaic and small hydropower, it will become increasingly difficult to find sites for wind farms that would not jeopardize the few remaining areas of wilderness, or encroach upon open spaces meant for recreation. The NIMBY syndrome would be increasingly operative

more so because installation of wind turbines near areas of real estate value lower the latter's worth. Offshore wind farms, discussed in Section 4 of this paper, suffer less from NIMBY but are not entirely free from it even as they suffer from other special problems of their own.

3.2. Noise

3.2.1. Nature and intensity of noise generated by wind turbines

Unlike the issues of esthetics as shaped by the conscious and the sub-conscious mind, which are associated with the visual aspects of wind turbines, noise is quantifiable on the decibels scale. Even then, a great deal of subjectivity is encountered when determining whether a noise is agreeable or disagreeable. Subjectivity is also associated with determining the degree of annoyance a noise may cause.

If one has to face it only for a short duration, the noise emanating from a wind turbine is not much of a distraction. But if the slapping/whistling/swishing sound of the whirling turbines has to be endured day in and day out, it can be annoying. The persistence of the noise is as big a contributing factor to its unpleasantness as its fluctuating levels or its nature. The awareness of the noise gets muted by the usual day-time din but it becomes very noticeable during the nights. If the nature of the locality is such that the background sounds generated by traffic and other forms of community noise are not strong, the sound of the turbines can become poignant.

Two forms of noise emanate from wind turbines—mechanical and aerodynamic. The mechanical noise is caused by the moving electromechanical parts of the machine. Its main sources are the machine's gear box, the electrical generator and the main shaft's bearings. The aerodynamic noise consists of the rotation noise and the turbulence noise [182]. Both are functions of the blade's aerodynamic design and the wind velocity.

The rotation noise increases with the rotor's diameter, the reduction of the blades' number, the blades' angular velocity, and the blades' aerodynamic load (increase of the captured wind energy).

The turbulence noise is produced by the vortex at the edge (tip) of the blades and the turbulence behind the rotor leading to an increase in the sound pressure levels (SPLs) with the tip speed. It goes down with the reduction of the blades' angular velocity; in other words greater the power being extracted by a turbine, more noisy it is.

Mechanical noise is in frequencies below 1000 Hz and may contain discrete tone components, which are known to be more annoying than noise without tones. But it is the aerodynamic noise which is the dominant component of wind turbine noise today, as manufacturers have been able to reduce the mechanical noise to a level below the aerodynamic noise. The latter will become even more dominant as the size of wind turbines increases, because mechanical noise does not increase with the dimensions of turbine as rapidly as aerodynamic noise does [191].

The sound power levels of a present day wind turbine are in the 98–104 dB(A) range at a wind speed of 8 m/s, which result in an exposure of about 33–40 dB(A) for a person living 500 m away. Studies by Pederson and coworkers [27,115,192,194–196] and Persson and Öhrström [193] have shown that SPLs of this low magnitude are not a source of annoyance when they come from other sources of community noise, such as road traffic and aircraft. But the sound from the wind turbine is amplitude modulated by the pace of the rotor blades, which gives a rhythmical swishing tone. Such sounds are more distracting than an even sound [270] and are, by-and-large, more negatively perceived.

Suitable locations for the installation of wind turbines are often in regions far away from urban clusters. In such rural settings, when

other forms of background community noise are not high, turbine-based noise easily stands out, contributing to its undesirability.

3.2.2. Factors which lead to annoyance or acceptability

As in the case of visual impacts, a good deal of research has been done to identify the social, economic, psychological and esthetic attitudes which make a person react accommodatively or unfavorably to wind turbine noise. Some broad pointers that have emerged are

- (a) the chances of a turbine's noise being perceived as a source of annoyance increase if the turbine is visible to the recipient of the noise;
- (b) those who economically benefit from the presence of turbines are less likely to feel annoyed by the turbine noise than those who do not derive such a benefit.

3.2.3. Possibilities of the masking of the wind turbine noise

Earlier work on other sources of noise such as emanating from industry had also revealed that those who benefit from the sources have high level of acceptance of the noise [170,171]. Also, visibility from the home (e.g., living room, bedroom) has been reported earlier, too, to affect annoyance from stationary sources [171].

Attempts have been made to see whether location of turbines in areas of pre-existing high background noise will face less opposition due to the masking of the turbine noise by the other background noise. In a study based in the Netherlands, Pedersen et al. [195] found that the presence of road traffic sound did not in general decrease annoyance with wind turbine noise, except when levels of wind turbine noise were moderate 35–40 dB(A) and road traffic noise level exceeded that level by at least 20 dB(A).

The extent of masking of wind turbine noise by the wind-induced rustling of vegetation has been investigated by Bolin [39] and by sea waves by Appelqvist et al. [21]. The extent varies with time as high turbine sound levels can occur when vegetation or wave noise is low, either on a short time scale during wind gusts or on a longer time scale associated with changes in the vertical wind profile. Also, as stated above, wind turbine sound can be audibly amplitude modulated due to differences in wind speed over the area swept by the rotor blades [243] and such amplitude modulations in a sound are more easily detected by the human ear [81] than a constant sound. This makes turbine-based noise conspicuous even if its average decibel level is not very high. This is borne out by several studies which indicate that at equal noise exposure levels, the expected annoyance due to wind turbine noise might be higher than annoyance due to other environmental noise sources [191,194,244]. The annoyance also appears to be high in comparison to exposure–response relationships for stationary sources, suggesting that wind turbines should be treated as a new type of source.

3.2.4. Reasons behind the unusual poignancy of wind turbine noise

In a study aimed to derive exposure–response relationship between wind turbine noise and the expected fraction of annoyed receptors, Janssen et al. [115] also find that in comparison to other sources of noise, annoyance due to wind turbine noise is found at relatively low noise exposure levels. In the overlapping exposure range, the expected percentage of annoyed persons indoors by wind turbine noise is higher than that due to other stationary sources of industrial noise and also increases faster with increasing noise levels. Furthermore, the expected percentage of annoyed or highly annoyed persons due to wind turbine noise across the exposure range resembles the expected percentages due to each of

the three modes of transportation noise at much higher exposure levels.

Janssen et al. [115] also note that besides noise exposure, other individual and situational factors are found to influence the level of annoyance. In the study of Janssen et al. [115] also it was seen, as recorded in previous reports mentioned above, that those who derive economic benefit from the use of wind turbines have much greater tolerance for the turbine noise than others. Those who are not directly benefited from the turbines feel enhanced annoyance by turbine noise if one or more turbines are visible to him/her from his/her home [192,245].

Another factor, according to Janssen et al. [115] that could possibly explain the disproportionately large annoyance caused by wind turbines is the manner in which wind turbine noise originates and travels. The noise is emitted from a level that is several heights above the receiver: for the present-day turbines it may be from levels 50 to 130 m over the ground. This yields an amplitude modulated sound, for example with an amplitude of 5 dB [246] and a modulation frequency of 0.5–1 Hz. Furthermore the SPLs are not constant but keep varying with the wind velocity, irregularly and unpredictably. Such amplitude modulated sound being easily perceived [81] become particularly conspicuous in otherwise quiet areas, where people do not expect to hear much background noise.

3.2.5. Impact on human health

But what about impact on the health and the well-being of the receptors? Community noise has the potential to be an environmental stressor, causing nuisance, decreased wellbeing, and possibly non-auditory adverse effects on health [194,226]. To what extent annoyance caused by the wind turbine noise can impact a person's health?

In a recent study, Bakker et al. [27] find that turbine sound exposure can be related to sleep disturbance and psychological distress among those who are annoyed by the sound. The authors conclude that people living in the vicinity of wind turbines are at risk of being annoyed by the noise, an adverse effect in itself, and noise annoyance in turn could have greater repercussions *vis a vis* sleep disturbance and psychological distress. Annoyance must mediate this response, as no direct effects of wind turbine noise on sleep disturbance or psychological stress has been demonstrated. In other words, residents who do not hear the sound, or do not feel disturbed, do not seem to be adversely affected. Bakker et al. [27] also find that the extent of exposure to the wind turbine SPLs appears to have a proportional impact on the level of annoyance of the receptors; more the exposure greater the annoyance. These findings have been reinforced by another recent study [196] which reveals that the odds of perceiving wind turbine noise as well as of being annoyed by it increases with increasing SPLs. A rural area increased the risk of perception and annoyance in comparison with a suburban area; and in a rural setting, complex ground (hilly or rocky terrain) increased the risk compared with flat ground. Annoyance was associated with both objective and subjective factors of wind turbine visibility, and was further associated with lowered sleep quality and negative emotions.

It can be said, all-in-all, that people who live close to wind turbines and do not benefit economically from the turbines are at risk to experience sleep disturbance and psychological distress due to the turbines. This risk increases with increasing levels of the turbine noise. Hence there is a need to take the characteristics of different settings into account when planning new wind farms so that adverse health effects associated with each setting can be avoided.

During the last two decades extensive research efforts have been vested to improve aerodynamic design of the wind turbine's blades. These efforts aim to increase the power output while reducing the blades' mechanical loads and the aerodynamic noise. But a success of the order of a mere 10% has been achieved in comparison to the noise that was generated by the wind turbines in the early eighties.

3.2.6. The portents

In essence the problem with wind turbines is not that they make great noise but, rather, is that in a large number of cases they make noise in areas which otherwise were much quieter. As cities expand and noise-free or low-noise habitations become increasingly harder to find, the intrusion of wind turbine noise in such locations will become an increasingly contentious issue.

3.3. Impact on wildlife, especially birds and bats

3.3.1. Early reports

Among the earliest reports of wind farms causing harm to wildlife, especially avifauna, are the ones that came from Altamont Pass, California [110,183] and at Tarefa and Navarre in Spain [32]. In all the three locations relatively rare and long-lived species of birds (hence the ones with low rates of reproduction and growth) were involved. For example Golden Eagle (*Aquila chrysaetos*) was the most worrisome casualty at Altamont Pass and the Griffon Vulture (*Gyps fulvus*) at Navarre. At Altamont, Golden Eagles run into turbines when they congregated to feed on abundant pray while at Navarre the wind turbines often came in the way of the birds when they had to fly through topographical bottlenecks (such as mountain passes).

3.3.2. Lacunae in the available information

Over the years several authors have tried to assess the extent of risk posed to birds and bats by wind turbines, and the possible ways to reduce or eliminate the risk ([22,32,44,54,65,70,71,76,131,141,162,167,209,216,222,224]). But, as almost always happens with environmental impact assessment, more and more previously hidden cross-connections and uncertainties are encountered as newer studies are done and the information is looked at with newer perspectives. In the matter of turbine-induced wildlife mortality, also, several such complexities are coming into view:

1. Much of the past data on bird/bat deaths by wind turbines has not been corrected for scavenger removal [70,79]. Given that scavenger removal can occur within a few minutes to just a couple of hours of the bird/bat death, this induces a substantial extent of underestimation of the risk [158].
2. Possibilities also exist on missing of death counts even before scavenger removal because of large areas encompassed by several wind farms [190].
3. Wildlife is not jeopardized by wind turbines only by way of direct hits. There is also habitat destruction, reduction in breeding success, shifting of the predator–prey equations which, all, can adversely affect wildlife due to wind power development [50,59,158,185,213,249].
4. Data such as number of birds/bats killed per turbine masks as much pertinent information as it reveals. Firstly all turbines do not kill flying animals evenly and in a wind farm, substantial hits may be occurring in certain pockets which few or none in other pockets [84,165]. Secondly the species involved may be as –or more–important than the total number suffering the hit [44,216]. Rare species, endangered species, and species with relatively longer life spans and low rates of reproduction will suffer much more than other species [49,70,71,89,213].

Overall, the factors that may influence collision risks are related to

- (a) turbine size, blade and hub design, and blade speed;
- (b) number and the positioning of turbines in a wind farm;
- (c) topography;
- (d) weather;
- (e) abundance of flying animals;
- (f) species of the flying animals, hence flight altitude, flying speed, maneuverability, time spent in flight, and extent of habitat specialization;
- (g) lighting.

3.3.3. Available pointers

The available information does reveal with fair certainty that the absolute numbers of turbine-killed birds and bats vary greatly among sites and that turbine collision risk of birds depends on a large number of factors, including bird species, numbers and behavior, weather conditions, topography, and the location size and the positioning of the wind turbines [90,139]. The risk is greater on or near areas regularly used by large numbers of feeding or roosting birds, or on migratory flyways or local flight paths. Large birds with poor maneuverability (such as swans and geese) are generally at greater risk of collision with structures [41,89] and species that habitually fly at dawn and dusk or at night are less likely to detect and avoid turbines [70,71,211,148]. Collision risk may also vary for a particular species, depending on age, behavior and stage of annual cycle. For example, work on terns by Henderson et al. [103] has shown that birds making frequent flights to forage for foods for their chicks are more susceptible to collision with overhead wires because they tend to fly closer to the structures lying in the path between foregoing sites and their nests.

More birds collide with structures when visibility is poor due to fog or rain [77,119,211]. Strong headwinds also affect collision rates and migrating birds in particular tend to fly lower when flying into the wind [204,265]. Collision risk in coastal and offshore areas is also likely to vary as birds move around in response to the state of tide and offshore currents.

As stated earlier, when rare, endangered, and slow-to-reproduce birds are involved, the impact of turbines can be decisive particularly in situations where cumulative mortality takes place as a result of multiple installations [70,71]. Some of the wind farms have caused enough deaths to have at least a local population-level effect on raptors [32,33,223,228,234] and seabirds [80]. The displacement of birds away from turbines can result in individuals abandoning otherwise suitable habitat, generally over distances of 100–200 m. These effects vary between sites, and species and season/stage of the annual cycle [68,108,109,136,147,149,189]. Garvin et al. [92] have shown that raptor abundance was reduced by 47% in Wisconsin, USA, after the construction of wind turbines in the study area than turbine kills. This reduction was more likely due to the abandonment of raptors from the wind farm project area. In a before–after impact study, Dahl et al. [59] have demonstrated that breeding success in territories of white-tailed eagles (*Haliaeetus albicilla*) adjacent to wind turbines can decline compared to before their construction resulting in a decline of the population growth. Carrete et al. [49] have shown that even a few turbine-killed Egyptian vultures (*Neophron percnopterus*) negatively affected the population growth of that species in Spain. Their study reinforces the premise that long-lived species are very sensitive to an increase in mortality, even if the increase is small [210]. Hence conclusions of low-impact drawn from some studies cannot be extrapolated to other locations and detailed site-specific assessments are necessary. For example a study on a 62-turbine wind farm in New Zealand by Bull et al. [44] showed that mortality occurred in 17 taxa but no bird of prey was killed. This information indicates that substantial shift in avian community structure was likely due to shifts

in predator/prey balances but such impacts are not quantified by mortality data.

Birds may get seriously injured or perish not only due to collisions with rotors, but also with towers, nacelles and other structures associated with wind farms such as guy cables, power lines and meteorological masts. Birds may also be forced to the ground as a result of being drawn into the vortex created by moving rotors [265].

If wind turbines are installed in topographies where birds have to funnel through confined spaces, significant risk of bird hits may arise. In some other situations, for example when following the coastline or crossing a ridge, birds lower their flight height [14,204]; this enhances their risk of collision with rotors [70].

3.3.4. Counter arguments that adverse impact is insignificant

Several forms of rebuttals exist to the claims that wind farms constitute a serious threat to avifauna. These include the following [168,211]:

- A much larger number of birds are killed by predators, poachers, and aeroplanes than by wind farms.
- In time birds develop the ability to 'sense' wind farms and avoid them
- Thermal power plants cause much bigger harm to wildlife habitat in general and birds in particular than wind farms do

None of the above arguments are false. But each masks the reality that even though wind farms are lesser evils than some other anthropogenic activities, the threat they pose is not insignificant. Even bigger reality these arguments mask is that the present extent of deployment of wind energy is very little compared to the scale at which it is planned to be used. The hub heights and blade lengths of the turbines are set to increase in future (Fig. 4) which would proportionately entrance the risk of damage to flying vertebrates. The sites that are 'ideal' in respect of high wind energy potential on one hand, and low adverse impacts on the other (for example minimum public opposition *vis a vis* visual intrusion and noise, harm to wildlife, etc.) are not easy to find. Hence the world will have to use less-than-ideal sites which will enhance the magnitude of the adverse impacts.

As for the ability of birds/bats to 'sense' wind farms and avoid them, there are several associated complications. The animals will have to spend greater energy to fly farther in their attempt at avoiding a large array of turbines. It will have the potential of disrupting linkages between distant feeding, roosting, molting and breeding areas otherwise unaffected by the wind farm [70]. The effect would depend on species, type of bird movement, flight height, distance to turbines, the layout and operational status of the turbines, time of day, wind force and direction, etc. The magnitude of impact will also be highly variable ranging from a slight diversion in flight direction, height or speed, through to significant diversions which may reduce the numbers of birds using areas beyond the wind farm. Moreover, a wind farm can effectively block a regularly used flight line between nesting and foraging areas. When there are several wind farms, which is how it will be when wind-based power generation attains its expected contribution of 20%, they will cumulatively create an extensive barrier which could force the birds/bats to take diversions of many tens of kilometers, thereby incurring substantial energy costs which may have knock-on impacts.

3.3.5. The emerging evidence

Even at the present, and much lesser than planned, level of utilization of wind turbines, evidence of their adverse impact on birds and bats is piling up. Pearce-Higgins et al. [190] collated bird

population records of wind farms located on unenclosed upland habitats in the UK to test whether wind farm construction impacted breeding densities more or the wind farm operation. From the available data for 10 species, they found that red grouse (*Lagopus lagopus scoticus*), snipe (*Gallinago gallinago*) and curlew (*Numenius arquata*) densities all declined on wind farms during construction. Red grouse densities recovered after construction, but snipe and curlew densities did not. Post-construction curlew densities on wind farms were also significantly lower than reference sites. Conversely, densities of skylark *Alauda arvensis* and stonechat *Saxicola torquata* increased on wind farms during construction, indicating that the construction-induced disturbance was causing a shift in the avian community structure. The authors [190] note that the majority of onshore wind farm proposals in the UK have been in upland areas due to the high wind speeds occurring there and their isolation from centers of human population [203]. But these areas also happen to support avifauna of high conservation importance [188]. Wind farm-developments may result in significant reductions in habitat usage by the birds to the extent of radial distances 100–800 m away from the turbines after construction (depending on the species). This could result in reductions in the abundance of some breeding birds by up to 50% within 500 m of the turbines [189].

Studies have indicated that increased human activity in and around wind farms can influence the use of nest sites, foraging sites and flight paths of the avia [71] as well as displace them into suboptimal habitats reducing their chances of survival and reproduction [59,88,158]. So far few, if any, conclusive studies have been carried out on the relevance of such factors, which is mostly due to lack of BACI (before–after–control–impact), assessments [70,138]. Of particular concern is the fact that raptors in general occur at low breeding densities [181], and absence of BACI studies makes it impossible to judge the extent to which wind farms may be impacting them [59]. These species generally mature late, lay few eggs and have a long life span, making their population growth rate especially sensitive to changes in adult mortality [210], as well as loss of prey [158].

3.3.6. Trans-continental impacts

It has been conjectured since long [117,140] that when turbines kill migrating birds and bats, the reverberations of the impact may be reaching far and wide, crossing even continental boundaries. Now evidence has come from a recent study, in which Voigt et al. [249] have assessed the geographic provenance of bats killed in summer and autumn at German wind turbines on the basis of stable hydrogen isotopes in fur. They found that among the species killed *Pipistrellus nathusii* originated from Estonia or Russia, and *Pipistrellus pipistrellus* from more local populations. Noctule bats (*Nyctalus noctula*) and Leisler's bats (*Nyctalus leisleri*) were of Scandinavian or northeastern origin. Obviously wind turbines kill bats not only of sedentary local populations but also of distant populations, thus causing declines in bat populations on a large geographical scale. Voigt et al. [249] suggest that international regulations should be set up for implementing mitigation measures to prevent such large-scale detrimental effects of wind turbines on endangered bat populations.

3.3.7. Need for studies on effected populations

A major reason for the inadequacy and uncertainty in our understanding of the impact of turbines on birds is that complete population and not just individuals living in the close vicinity of turbines need to be monitored before and after the installation of a wind power plant. Only when such studies are conducted, useful knowledge about the impact of wind turbines on population growth rates of potentially affected species will accrue because

the ultimate measure of the impact of any action on a community of animals is the growth rate of their population [141,166,213]. A few years back Drewitt and Langston [70] had pointed out that further research to develop spatial and demographic models is needed which can help predict effects of individual wind farms and groups of developments which have cumulative effects across extensive areas. But such studies are still to be conducted.

Simulation modeling by Schaub [213] have revealed clear effects of both the number of wind turbines and their spatial configuration on the growth of a red kite population: the larger the number of wind turbines and the more they were spread out in a landscape, the more depressed the population growth rate became. Bird species having larger home ranges were seen to be much more negatively impacted by an increasing number of wind turbine locations than species with small home ranges.

Simulations by Schaub [213] also show that an enhancement of the collision risk from 0.5 to 0.8 would have a strong negative effect on population growth, thereby indicating that the potential of wind turbines to harm avifauna cannot be underestimated.

3.3.8. The proposed strategies to prevent or reduce harm to birds and bats

As of now the usual assurances that are given when promoting any and every developmental activity that threatens to harm the environment, are given for new wind farms as well, viz “the activity will not adversely affect the environment if planned and implemented with proper environmental safeguards.”

In case of the impact of wind energy on wildlife, the safeguards that have been proposed are

- A wind park should be so designed as to eliminate the probability of harming the natural environment significantly, especially birds. All possible impacts on birds and other wildlife should be considered beforehand.
- Systematic pre-construction studies and post-construction forecasts should be made to explore the potential impacts of wind parks on wildlife and determine wind farm siting in a way that optimizes electricity production while maximizing conservation of wildlife.
- Necessary measures for the protection of birds must be introduced during the wind park's construction and operation.
- Collaboration should be fostered between the wind farms' developers, the relevant governmental agencies, and laypersons to ensure proper siting, construction, operation, and maintenance of wind farms.

As with all other activities, for wind farms also ‘longer-term’ impact assessment studies are advocated with extensive data collection and proper follow up on its basis to ensure that little or no adverse impacts are caused.

It is possible to draw a long list of ‘dos’ and ‘don’ts’, of best practice measures, with which harm to birds, bats and other wildlife from wind power projects can be minimized. For example

- (i) ensuring that key areas of conservation importance and sensitivity are avoided;
- (ii) conducting systematic ‘before’, and ‘during’ surveys to assess adverse impacts and minimize them;
- (iii) ensuring appropriate working practices and restoration measures to protect sensitive habitats;
- (iv) providing adequate briefing for site personnel and, in particularly sensitive locations, employing an on-site ecologist during construction;
- (v) ensuring a vigorous post-development monitoring program by stipulating it as a pre-requisite for licensing the wind farm;

- (vi) siting turbines close together to minimize the development footprint (subject to technical constraints such as the need for greater separation between larger turbines);
- (vii) grouping turbines to avoid alignments that are perpendicular to main flight paths of the avia and to provide corridors between clusters, aligned with main flight trajectories, within large wind farms;
- (viii) increasing the visibility of rotor blades to the extent it is compatible with the landscape, and using UV paint, which may enhance the visibility of rotor blades to birds;
- (ix) installing transmission cables underground, wherever possible;
- (x) marking overhead cables using deflectors and avoiding use over areas of high bird concentrations, especially for species vulnerable to collision;
- (xi) timing construction to avoid sensitive periods;
- (xii) implementing habitat enhancement for species using the site;
- (xiii) carefully timing and routing maintenance trips to reduce disturbance from boats, helicopters and personnel (in case of off-shore turbines);
- (xiv) fostering collaboration between the wind farm developers, relevant government agencies and people living close to the farms to ensure proper siting, construction, operation, and maintenance of the farms according to agreed ‘best practice codes’.

It can be added that extensive BACI studies on avifauna at local as well as regional levels should be made mandatory to ensure that any possible harm to the birds during construction is minimized while any adverse post-construction impact, if detected, may be ameliorated. Risk assessment frameworks as proposed by Garthe and Hüppop [90], and refined by Christel et al. [54], Furness et al. [89], Seaton and Barea [216], De Lucas et al. [65] and others can be helpful in quantifying BACI. Techniques and methodologies introduced earlier to assess risk of accidents can also be made a basis for developing BACI assessment tools [122–130,273].

3.3.9. The portents

For any and every developmental activity, it is possible to say, “the adverse impacts will be minimal if ‘best practice’ is adopted.” In turn the ‘best-practice’ comprises of the kind of actions listed above which not only need input of state-of-the-art technology, but commitment on the part of all stakeholders and a great deal of investment. But investments in environmental protection reduces the short-term profitability of any venture and there is a general tendency to keep such investments to a minimum. Even governments bypass their commitments towards environmental safeguards in their anxiety to make energy projects ‘profitable’ [5,8]. So many violations of environmental concerns are occurring, so commonly and at such a large scale that ‘best practice’ recommendations are followed in breach rather than in compliance. To what extent wind farm developers across the world will like to invest money in protecting birds and bats? Wisdom of hindsight tells us that the plausible answer is ‘not much’.

Another major difficulty with the ‘best practice’ paradigm is that what we call best practice at any point of time is dependent on the extent of our grasp of the situation at that point of time. Until two decades ago best practice for thermal power projects vis a vis gaseous emissions meant control of SO_x and NO_x. Control of CO₂ was not a concern at all. Likewise, till very recently no set of best practice guidelines for hydropower or geothermal projects carried any instructions to deal with methane or N₂O emissions. As the number of wind farms go up, and as other developmental pressures add to the threat being faced by wildlife, the measures

that appear adequate today may prove ineffective in the near future.

Yet another problem is that best practice is a contextual phenomenon: what is best practice for a city, state, or country is not necessarily a best practice for another city, state, or country. Given this reality, even national consensus on best practice is difficult to arrive and what is agreed upon gets deviated here and there due to compulsions of accommodating conflicting interests. The prospect of achieving global consensus and commitment on truly best practice appears remote.

If best practice is difficult to specify it is very difficult to legislate, and, on the ground, almost impossible to enforce. In India, for example, very elaborate and strict norms for best practice exist for all kinds of developmental activities. Technology, manpower, and other resources to implement the best practice are also available. No industry, power project, or any other developmental activity is allowed without elaborate EIA and written commitments that best practice shall be followed. Despite all this, numerous factors operate to cause major deviations from best practice. There are governmental agencies and nongovernmental watchdog groups to prevent this but even the task of randomly policing a statistically significant number of industries is so huge that across-the-board enforcement of best practice has been impossible.

3.4. Shadow flicker

Shadow flicker is a unique impact associated with only wind energy form among all other energy sources. When it occurs fleetingly, a flicker is totally benign and is barely noticed. But a persistent flicker can be as disconcerting as lights coming on and going off in a room in quick succession for several hours.

The blades of a wind turbine cast a shadow when sunlight or some other light from a strong source falls on them. If the blades happen to be rotating, a flicker is generated. Depending on the angle of the incident light and its intensity the flicker may cause feelings ranging from undesirable to unbearable [58,247].

On a clear day, and a little after the sunrise and a little before the sunset, the shadow of a 22 m turbine blade may be visible up to a distance of 4.8 km. The flicker of a 3 MW wind turbine, which has a blade of about 45 m length and 2 m width, may be visible up to a distance of 1.4 km in one or other direction for most part of the day. Weaker shadows may be cast up to a distance of 2 km from the turbine [120,247]. At dusk the flicker may distract drivers, heightening risk of accident [154].

Alongside the area of impact, which grows larger with taller turbines and longer blades, the relevant aspect is the flicker frequency. Indeed it is the flicker frequency which is the principal cause of annoyance and should be kept at no more than three blade's passes per second, or 60 rpm for a three-bladed turbine. The flicker would be sharper if turbine blades are reflective. The strategy to reduce flicker by reducing blade speed acts against turbine efficiency.

In the course of a day, the shadow of a wind turbine moves as the sun rays change direction from east to west. Since the sun-path changes during the year, the route of a wind turbine's shadow also changes from season to season. It is a mixed blessing—the positive side is that any area suffers from a wind turbine's shadow flicker for only a specific duration in an year. The negative side is that overall a much larger area comes within the impact range of the flicker making the challenge of addressing this problem that much greater. In certain situations, for example in the island of Crete studied by Katsaprakakis [120], which has small mountainous settlements dispersed everywhere, impacts of wind turbine noise and flicker are impossible to avoid.

The only way to prevent flicker from causing annoyance is to locate wind farms well away from where people live. This adds yet

another difficulty to the problem of finding sites for locating wind farms.

3.5. Electromagnetic interference

The possible ways in which wind turbines can cause electromagnetic interference are [35,99]

- distorting the transmissions of existing radio or television stations;
- generating their own electromagnetic radiation.

Transmission signals from radio or television (especially of FM broadcast frequencies) can get distorted when passing through the moving blades of wind turbines. This effect was more pronounced with the first generation wind turbines which had metallic blades. The present day wind turbines are exclusively made of synthetic materials which have much milder impact on the transmission of electromagnetic radiation [227,261]. The flip side is that a very large number of telecommunication towers now exist everywhere which were not there during the first generation wind turbine era. Hence the number of people likely to be impacted has grown enormously. In some of the countries license for a wind park is granted only if certain prescribed minimum distances are kept from telecommunications or radio and television stations. This places yet one more hindrance in the path of the siting of wind farms. Installation of additional transmitter masts can alleviate the problem but at a cost.

As far as the generation of electromagnetic radiation by wind turbines is concerned, the parts of a wind turbine which may contribute are the electric generator and the voltage transformer. The electromagnetic fields these parts generate are weak and are confined to within a short distance from the turbine housing [43,217]. They nevertheless add to the already increasing background electromagnetic radiations (EMRs) load caused by telecommunication towers. They also add to the exposure of humans to EMR which has dramatically increased in recent years due to cell phone use [202] and which is being implicated with the risk of cancer, among other health risks.

3.6. Land requirement

Proponents of wind energy argue that wind farms do not actually occupy as large land areas as appears from a cursory glance. A 3 MW wind turbine needs about a 40 m × 40 m chunk of land, or a 1600 m² square, outside which agriculture or any other land-use activity can go on unhindered [120]. This is true, too, for certain types of land-uses such as for pasture or horticulture. But when the number of wind farms increase dramatically to meet the kind of targets that have been advanced by the IPCC [113] it would be increasingly difficult to find large areas to locate wind farms without coming into serious conflict with the existing land-use. Moreover recent findings as detailed in the following section indicate that wind turbines can enhance water loss and require greater expenses than would otherwise incurred in irrigation. They also raise temperatures downwind which may have difficult-to-forecast impacts on agricultural production, of which at least some can be unfavorable.

3.7. Climate change

Due to the temperature differences that are generated at planetary scales by the non-uniform heating of the earth by the sun, winds of different speeds are created throughout the atmosphere. The turbulent mixing caused by these winds in the upper atmosphere transports momentum downward towards the earth's

surface. The average downward flux of kinetic energy in this manner over the global land surface is about 1.5 W m^{-2} . It is small in magnitude but influences much larger energy fluxes by the heat and moisture that the winds transport. Parts of this flux are extracted by wind-turbine arrays [42]. In absolute terms the magnitude of power thus extracted is a miniscule fraction of the power carried by winds across the globe, but in the context of near-surface hydrometeorology the proportion extracted is significant enough to cause major perturbations, as explained below.

When wind masses move across the blades of a wind turbine, a sizeable fraction of the wind's momentum is transferred on to the turbine which converts it into electrical energy. The yearly average flux of kinetic energy that passes through a tall and large wind turbine is of the order of 1 kW m^{-2} . Significant fractions of it are transformed into electrical energy by the turbine and the exiting wind has that much less momentum. These happenings in the wake of each turbine have the effect of disturbing the natural exchanges of energy between the land surface and the atmospheric layers close to it. This may alter the local hydrometeorology and may have a cascading effect on atmospheric dynamics.

Two groups of scientists—Baidya Roy et al. [26] and Keith et al. [121], working independent of each other—were the first to suggest that utilization of wind for power generation on a large scale may influence the global climate. The report of Baidya Roy et al. [26] was based on the premise that even though the rate at which wind farms extract energy from the atmosphere is miniscule in comparison to the kinetic and potential energy stored in the atmosphere, it is highly significant in time-tendency terms—for example rate of conversion of energy from one form to another, frictional dissipation rate, etc. Parallely, and independently, Keith et al. [121] expressed the same possibility, Keith et al. also suggested that alternation of the wind-based kinetic energy fluxes in the course of power extraction by wind turbines can have much stronger influence on the climate than alternation in radiative fluxes of identical magnitude. This is because of the wind's role, mentioned above, in mediating much larger energy fluxes by transporting heat and moisture.

Both groups had based their theories on the modeling of hypothetical wind forms. Their reports have, expectedly, generated a debate which continues to rage in much the same way it had happened *vis a vis* global warming [10]: for a long time more people believed that global warming was the figment of imagination of a few paranoid scientists and was, at worst, a very distant possibility. A number of calculations were advanced to show that either there is no significant warming or, if there is some, it is of no net harm. Indeed for some years during the 1970s and early 1980s it was global *cooling* that was forecast and feared by a section of scientists [61,173,232]. In case of the effect of wind turbine operation on climate, also, reports based on theoretical studies have appeared which suggest that the impact will be insignificant [225]. But concrete evidence is beginning to emerge that wind farms do impact the local climate.

On the basis of an analysis of satellite data for the period of 2003–2011 over a region in west-central Texas, where four of the world's largest wind farms are located, Zhou et al. [267] have found a significant warming trend of up to 0.72°C per decade, particularly at night-time, over wind farms relative to nearby non-wind-farm regions. The authors have been able to link this warming to the impact of wind farms because the spatial pattern and magnitude of the warming has coupled very well with the geographic distribution of wind turbines.

The findings of Zhou et al. [267] have been corroborated by an independent study on San Geronio Pass Wind Farm situated in southern California, by Walsh-Thomas et al. [254]. These authors have found that downwind regions, south and east of the wind farms are typically warmer than those west of the wind farm. The extent of

downwind warming varied from 4 to 8°C . A typical pattern of downwind rise in ambient temperature as observed by Walsh-Thomas et al. [254] is presented in Figure 5.

Theoretical studies are also piling up which forecast significant impact on climate of wind turbines. It has been shown [12] that large wind farms directly influence the atmospheric boundary layer by (a) reducing wind speeds, (b) generating blade scale turbulence in the wake of the turbines, and (c) generating shear driven turbulence due to the reduced wind speeds in the turbine wake. Large wind turbines can also have indirect effects on the local climate by influencing surface roughness, advection of heat and moisture, and turbulent transport in the boundary layer [132].

Wang and Prinn [255] have used a three-dimensional climate model to simulate the potential climate effects associated with installation of wind-powered generators over large areas of land or coastal ocean. It is seen that using wind turbines to meet 10% or more of global energy demand (as has been proposed by the IPCC [113]), could cause surface warming exceeding 10°C over land installations. The model forecasts that impacts resulting in significant warming or cooling can occur even in places remote from wind farms. Alterations of the global distributions of rainfall and clouds can also occur. The impacts have their origin in the competing effects of increases in roughness and decreases in wind speed on near-surface turbulent heat fluxes, the differing nature of land and ocean surface friction, and the dimensions of the installations parallel and perpendicular to the prevailing winds.

3.7.1. Suggested measures and their limitations

Baidya Roy and Traiteur [208] have explored the possibility of low-impact wind farms to minimize the impacts on surface temperature. One option to achieve it, according to the authors, is to design rotors that generate less turbulence in their wakes, thereby lessening the downstream impacts on the local climate. The other option is to locate wind farms in areas where background atmospheric boundary layer (ABL) turbulence is high due to natural reasons.

Of these, the engineering solution is expensive because it involves designing new rotors. The siting solution is convenient in terms of its reliance on currently available technology, but it requires wind farms to be sited in regions with high background ABL turbulence. Firstly, prolonged exposure to such turbulence may be damaging to the rotors, and, secondly, it may put wind farms away from the points of use of their power, enhancing transmission costs and losses. There are also suggestions that the extent of wind energy extractable across the world is about half of what has been estimated is the past [13].

It is often said in support of wind farms that they can be put up over agricultural land, thereby enhancing land-use without major disturbance in the existing land-use. Such siting can also help farmers in supplementing their income with rent from utility companies. But impacts from wind farms on surface meteorological conditions such as enhancing water loss from soils due to higher rate of evaporations, are likely to affect agricultural practices in these farms [271,272]. One of the direct consequences may be the necessity to spend more money on irrigating the affected area [215]. If the wind farms are sufficiently large, they may affect downstream surface meteorology a long way. As wind farms become larger and more ubiquitous, such impacts may multiply.

4. Environmental impact of offshore wind farms

Whereas onshore deployment of wind energy for generating electrical power has a history going back to the 1880s, the first offshore wind turbine was installed only a few decades ago—in 1991 [46]. As a result, the world has had much lesser time to

experience the adverse impacts of offshore wind farms (OWFs) in comparison to inland wind farms (INFs) but some advantages of the former have appeared obvious. If an OWF can be installed so far off in the sea from the coast that it goes out of sight of beach-farers, the problems of adverse visual impact, noise-related trauma to humans, image flicker, and electromagnetic interference can be largely avoided. Concerns of real-estate value of land and the prospect of the value getting jeopardized by wind turbines also do not operate in case of OWFs. Hence the biggest hurdle in the path of wind energy development—public opposition on account of the NYMBI syndrome—may be largely bypassed. These perceived advantages on one hand, and the pressures to reduce the contribution of fossil-fuels to the energy mix on the other, has prompted great efforts to take wind-based power generation offshore. Indeed the quantum of envisaged OWF-based electricity generation is so high that, if implemented, it would dwarf the INF-based initiatives.

But, by all indications, even as OWF may take some of the old problems out of sight, hence out of mind, they may generate massive new problems of their own. Marine environments are already under severe stress due to overfishing [40], pollution [53,251], ozone hole-related UV-B exposure [60,99,197], and ocean acidification [8,133,169]. Installation of large wind farms will jeopardize the marine environment still further. Of particularly serious concern is the situation in countries like Scotland who wish to simultaneously exploit marine wind, wave, and tidal energy sources, each on large scale [73]. As practically nothing is known about the cumulative impacts of such development, it amounts to a very risky leap into the unknown. Impacts of OWF encompass [73]:

- Acute noise-related impacts during construction phase, especially due to driving, drilling and dredging operations.
- Disturbance due to intensive marine and aerial transportation activities during exploration, construction and maintenance.
- Generation of polluted sediments during construction and their re-suspension.
- Collisions of birds and other organisms with OWF structures.
- Creating of the artificial reef effect by the presence of structures, individually and in arrays, with concomitant impacts on biodiversity.
- Chronic, long-term, impacts due to continual operational noise and vibrations emanating from OWF.
- Electromagnetic impacts arising from underwater cable networks that may interfere with animal navigation.
- Thermal impacts that may aggravate the impacts of other stressors on the benthos.
- Impacts of episodic traffic increase for trouble-shooting.
- Impacts during physical decommissioning, particularly the steps which would involve the use of explosives.

Among the adverse impacts of OWF are those that are common to IWF: collision risk to birds and bats [22,25], noise, and electromagnetic interference (EMI). The difference is that the last two impacts will not harm us directly as IWFs do, but shall harm us indirectly by adversely effecting marine ecosystem. In addition OWF pose significant risk to marine invertebrates, fish, and mammals due to habitat fragmentation, noise, vibrations, electromagnetic interference, etc., just as IWFs pose a risk to land-based wildlife [158].

4.1. Impact of anchorage, or the 'artificial reef effect'

There have been reports that the anchorage off-shore platforms provide to invertebrates and fish may be beneficial for their growth. For example oil platforms and piers are known to attract marine

organisms [102,157]. There are even reports that the density and biomass of fish in some of the artificial habitat created by man-made structures was found to be higher in comparison to the surrounding areas and even local natural reefs [258,260]. But the species composition in such 'artificial reefs' is vastly different from that of the natural reefs and may impact the biodiversity of surrounding areas [56,112,205]. Such structures are also known to promote the establishment and spread of alien species and harmful algal blooms [45,187,248]. Moreover the perception of enriching fisheries may be illusory as it may arise due to migration from surrounding areas and, thus, may be occurring at the expense of previously unexploited stock [95]. According to an estimate of [262], the net amount of monopole exposer per offshore turbine creates 2.5 times the amount of area lost to placement of monopole on the sea bed.

'Floating' wind turbines, which are anchored to the sea bed but are free to move on the surface, have extensive moorings and are known to facilitate aggregation of fish [82,250,259]. But, again, it is not clear whether these devices increase recruitment or merely attract fish from nearby areas [52,112]—if the latter occurs the devices would be a means of over exploitation, hence net decline rather than promotion of fisheries.

As for benthos, the artificial reef effect will benefit some species but may negatively affect others [145]. Structural elements placed in sand bottoms may result in greater benthic diversity [116], but this may also affect adjacent communities through greater predation [146]. All-in-all OWFs are expected to change faunal community from those associated with sand/gravel habitat to those who use reefs [163]. Shifts in floral communities would also occur [153].

4.2. Collision risk

There is even much less information and much greater uncertainty associated with collision risk posed to birds and bats by OWFs than is the case with IWFs. As happens at IWFs, birds may show two kinds of avoidance behavior at OWFs which can be termed as 'macro-avoidance' and 'micro-avoidance'. The former occurs when birds alter their flight path to keep clear of the entire wind farm [67], whereas the latter occurs when birds enter the wind farm but take evasive action to avoid individual turbines [31,55]. Unless species-specific rates of macro- and micro-avoidance are known, it is not possible to assess vulnerability of different species or the overall population. But such data is lacking and what little is available, is fraught with uncertainty [55,89]. Since most carcasses are usually not found in OWF areas, it is even more difficult to ascertain OWF-related bird mortality than is IWF-related bird mortality.

What can be said with certainty is that large number of factors can heighten collision risk of birds at OWFs. These include characteristics of turbines and geometry of arrays formed by the turbines, weather conditions, topography, bird species, and numbers of birds using the site. Species-specific risks are a function of flight altitude, flight maneuverability, percentage of time spent in flying, nocturnal behavior, and habitat specialization [89,90,214]. Wind farms located along the migratory routes or in habitats frequented by birds would carry greater collision risk. Turbines constructed linearly in long strings may cause more avian collisions than turbines that are constructed in clusters. The heights, blade lengths, tip speeds, blade appearance to birds, and presence and type of lighting are other factors that determine the collision probability. Turbines featuring taller towers and larger blade lengths with slower tip speeds pose greater collision risks to flying animals [175]. Species abundance at wind farms may also influence collision risks because collision rates at some wind farms are higher for those species that are the most abundant.

Although migrating birds generally fly at altitudes higher than 150 m, they descend to lower altitudes during high winds, low clouds, and rain. This increases the probability of them hitting the wind turbines.

As OWFs carry navigation lights, which have the potential to attract seabirds, there is additional risk of collision due to the lights [176]. The few studies that have been done so far suggest that impacts are highly dependent on the site in terms of conservation importance of the impacted species as well as physical factors that influence the probability of a hit ([70,87,90,159,229]. In general OWF may have a negative impact on local bird abundance [229]. Moreover indirect impacts on avifauna can occur as OWFs can disrupt or remove feeding and/or breeding habitats.

As for collision risk between submarine animals and OWF, virtually nothing is known [263] have conjectured that fixed submerged structures are likely to pose little collision risk, but cables, chain, power lines and components free-moving on the surface or in the water column may pose a much higher risk of collision. A variety of marine organisms are attracted to marine light sources of the type present on OWF [100,164] which may heighten collision risk.

4.3. Noise

There is an increasing body of evidence that noise has the adverse effect over a range of aquatic organisms, especially vertebrates [74,107]. OWF will be a source of significant extra noise, not only during the construction phase but during operation as well, and may impact marine life due to it [57,63,179,180,235]. Acoustically sensitive species such as marine mammals are likely to be particularly vulnerable as pile-driving has been observed to directly affect the behavior of seals [75] and cetaceans [51,104,238]. For example, [51] found that harbor porpoises appeared to leave the construction area of an offshore wind farm after pile driving (which produces sound in excess of 205 dB) commenced. In the marine environment, hearing is a much more important sensory input than vision, and cetaceans, in particular, have highly-developed acoustic sensory systems with which they communicate, navigate, forage and avoid predators [73]. Fish can also detect pile-driving noise over large distances, which may affect intra-specific communication, or may dampen their ability to perceive lesser sounds, making them lose orientation or make them more vulnerable to predation [200,235].

Noise during the operational phase is likely to be less poignant and its significance may lie in terms of chronic, long term effects. [135] examined the response of porpoises (*Phocoena phocoena*) and seals (*Phoca vitulina*) to simulated 2 MW wind power generator noise, and found that the seals surfaced at greater distances from the sound source compared to distances without noise. Similarly, approach distance to porpoises increased when the simulated generator noise was turned on. By an estimate ([235]) the operational noise of wind turbines will be audible to *P. phocoena* positioned 100 m away, and to *P. vitulina* over 1 km away. Fish may not get traumatized by OWF noise but the noise may mask their communication and orientation signals [20,252].

Little is known with which to conjecture as to how other marine animals will react to OWF noise. Sea turtles have been shown to suffer stress from anthropogenic noise [212], but no *in situ* studies exist [163]. A recent study [199] has shown that simulated wind turbine noise significantly increased the median time to metamorphosis for the megalopae of crabs *Austrohalice crassa* and *Hemigrapsus crenulatus*.

Based on an assessment of the state-of-the-art, [221] aver that OWF pose a significant risk to whales, dolphins and porpoises, even as proponents of OWF have been hoping that possible benefits (e.g., artificial reef creation) may take precedence over

the negative impacts if—and it is always a very big ‘if’—mitigation strategies are effectively implemented [198].

4.4. Electromagnetic interference and temperature rise

OWFs depend on intensive network of electrical cables to transfer power between devices, to transformers and to the mainland. The resulting electromagnetic fields (EMFs) will be of similar strength to that of the Earth in close proximity to the cables [253], and so have the potential to affect magnetosensitive species such as bony fish, elasmobranchs, marine mammals and sea turtles [96,160,264]. EMFs could also affect animals which use geomagnetic cues during migration [155].

For example eels have been seen to respond to EMFs by diverting from their migration route [256]. Benthic elasmobranchs also respond to EMFs emitted by subsea cables. As for direct impact of EMF on animal health, little is known with certainty as of now. As brought out by Lovich and Ennen [158], perceptions of different assessors range from ‘minor’ [198,211] to major [28–30]. It is suggested that chronic EMF exposure could impact nervous, cardiovascular, reproductive, and immune systems of impacted wildlife.

Moreover there are predictions that electricity production at OWF will increase the temperature in the surrounding sediment and water. Perhaps the thermal effect may be just a small rise in temperature within a few centimeters of the cable and may, by itself, be not a major stressor to benthic communities but in combination of other stressors might assume significance. The development, operation and decommissioning phases, of an OWF will span many decades and would be a hub of activity that will impact marine ecosystem in many ways—quite a few of which the nature and extent is unknown and quite a few not even foreseen as of now.

4.5. NIMBY

OWFs are much less affected by the NIMBY (not in my backyard) syndrome that besieges IWFs but are not entirely free from it [37,101,257]. Farther on OWF is located from the shore more costs and greater carbon footprint it entails by way of increased transportation and transmission costs. Closer to shore it is more visually intrusive it becomes. Particularly contentious are the issues relating to eco-tourism [257], and no broad consensus or formula exists on how to get around these issues. What is known with certainty is that OWFs cost 1.5–2 times more to install and 5–10 times more to maintain than IWFs of comparable capacities [261].

4.6. Vibration and flicker effects

Wind turbines produce infrasound that are below the audible range of humans but are potent enough to cause houses and other nearby structures to vibrate [2]. Several species of animals are able to perceive such low-frequency vibrations through their skin. It is this ability which enables several animals to ‘foresee’ earth quakes and tsunamis before the calamities actually strike them [47,94]. It is likely that vibrations caused by OWF may mislead some of the marine species and may mask vibration-related cues in some other.

Likewise the light flicker generated by wind turbines may be stressful to marine fauna but absolutely nothing is known about it.

5. Life cycle assessments

A large number of life cycle environmental impact assessments have been done of wind power and even several assessments or reviews are available of those assessments [19,23,64,72,85,98,137,152, 239,268]. Given that an LCA is [97] a “compilation and evaluation of

the inputs, outputs and potential environmental impact of a product system throughout the life cycle”, the results of an LCA depend very strongly on what all is included, in what form, and with what weightage. A great deal of subjectivity becomes unavoidable [64], so does imprecision. As a consequence, despite hundreds of LCAs, already done, and new ones continuing to be reported [93,186,206] it is not possible to say with any certainty how much more beneficial to environment wind energy is in comparison to other sources of energy. For example the CO₂ emission intensities of wind power as arrived by different LCAs vary from 7.9 to 123.7 g/kWh of electricity generated [64]. Return on investment (ROI) results of 50 studies compiled by [137] range from 1.8 to 125.8! Larger turbines leave smaller ecological footprint per kW of power they generate [48,66], but have greater adverse impacts than smaller turbines have, in terms of visual disagreeability, collision risk to avifauna, impact on weather, etc.

Several factors contribute to the discrepancies between different LCAs: difference in scales of systems (such as large/small turbines), key assumptions (such as lifetime, capacity), basic data (such as emissions associated with constituent materials), and the type, range, and coverage of the LCA [19]. A lot, eventually, depends on what the author of the LCA hopes to highlight—the LCA, then, consciously or sub-consciously tends to acquire that orientation. It is generally agreed that OWFs use up more fossil fuels than IWFs because OWFs need more intense and regular transportation for their commissioning, operation and maintenance, and decommissioning, than IWFs do [206].

Reports have also appeared (e.g. [168]) which estimate harm to human health and environment caused by fossil fuels in monetary terms and show that we gain that much cost advantage from wind energy by way of the averted harm. But such estimates are based on a tacit assumption that wind energy would have no different or no greater total impacts when used to meet 20% or more of global energy demand than they are exerting at their present (and miniscule) level of utilization. There is no rationale behind such an assumption.

6. Summary and conclusion

Wind energy is the most extensively utilized of all renewable energy sources at present (if large hydropower is not considered as it usually is not), even as its contribution to the global energy production is a mere 0.2%. Now moves are afoot all over the world, especially in the USA, the EU, China and India, to substantially enhance the share of wind energy. The Inter-governmental Panel on Climate Change expects the world to meet 20% of its energy demand with wind energy by the year 2050. This means the world would need to generate 50 times as much power with the use of wind by 2050 as it is doing at present.

But even with the present levels of the use of wind turbines, adverse environmental impacts are increasingly coming to light. The paper summarizes the current understanding of these impacts and tries to assess how their magnitude is likely to increase with the increase in the deployment of wind turbines. It is seen that the adverse impacts are likely to be substantial and their impacts may increase in complexity and magnitude in proportion to the extent of use of wind as an energy source.

Among the major hurdles in the path of wind energy development so far has been the NYMBI (not in my backyard) syndrome due to which there is increasing emphasis on installing windfarms several kilometers offshore. But such moves have serious implications for the marine life which is already under great stress due to impacts of overfishing, marine pollution, global warming, ozone hole and ocean acidification. Evidence is also emerging that the adverse impacts of wind power plants on wildlife, especially birds and bats, are likely to be much greater than is reflected in the

hitherto reported figures of individuals killed per turbine. Likewise recent findings on the impact of noise and flicker generated by the wind turbines indicate that these can have traumatic impacts on individuals who have certain predispositions. But the greatest of emerging concerns is the likely impact of large wind farms on the weather, and possibly the climate.

The central message of the review is not that wind energy is a greater evil than fossil fuels. It, rather, is that large scale replacement of fossil fuels with wind energy will not be as unmitigated a blessing as has been widely believed on the basis of generally small-scale and highly dispersed use of wind energy accomplished so far. The review also gives the message that a shift to renewables like wind energy may be beneficial only if it is accompanied by a reduction in the overall energy use.

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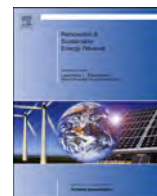
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ATTACHMENT D:

Shifeng Wang et al., *Impacts of Wind Energy on Environment: A Review*, 49 RENEWABLE
AND SUSTAINABLE ENERGY REV. 437 (2015)



Impacts of wind energy on environment: A review



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ARTICLE INFO

Article history:

Received 4 February 2014

Received in revised form

19 June 2014

Accepted 23 April 2015

Available online 15 May 2015

Keywords:

Wind power

Bird fatality

Bat fatality

Greenhouse gas

Environmental impact

ABSTRACT

Wind power is increasingly being used worldwide as an important contribution to renewable energy. The development of wind power may lead to unexpected environmental impacts. This paper systematically reviews the available evidence on the impacts of wind energy on environments in terms of noise pollution, bird and bat fatalities, greenhouse gas emissions, and land surface impacts. We conclude that wind energy has an important role to play in future energy generation, but more effort should be devoted to studying the overall environmental impacts of wind power, so that society can make informed decisions when weighing the advantages and disadvantages of particular wind power development.

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1. Introduction

The dual challenges of climate change and energy security mean that renewable technologies are required in the future. Wind energy is considered to be an important source of renewable energy and has been used commercially to produce energy services in the United States (US) since the early 1980s. It has become an increasingly important sector of the renewable energy industry, and may help to satisfy a growing worldwide demand for electricity [1,2]. Wind power has been rapidly developed

worldwide (Fig. 1) [3]. The European Union alone passed the 100 Gigawatts (GW) capacity in September 2012, while the US and China surpassed 50 GW and 50 GW in August 2012, respectively [4–6]. Worldwide, there are now over two hundred thousand wind turbines operating, with a total capacity of 282 GW at the end of 2012 and a global annual installed wind capacity of 44.71 GW in 2012 [3]. The average annual growth in new installations was 27.6% between 2005 and 2010 [3,7]. Based on current growth rates, the World Wind Energy Association (WWEA) [8] projects the global cumulative installed wind capacity to be 1,900 GW by the end of 2020. Wind power market penetration is expected to reach 8% by 2018 [9].

However, development of wind power could lead to unexpected environmental impacts on ecosystems, due to the many

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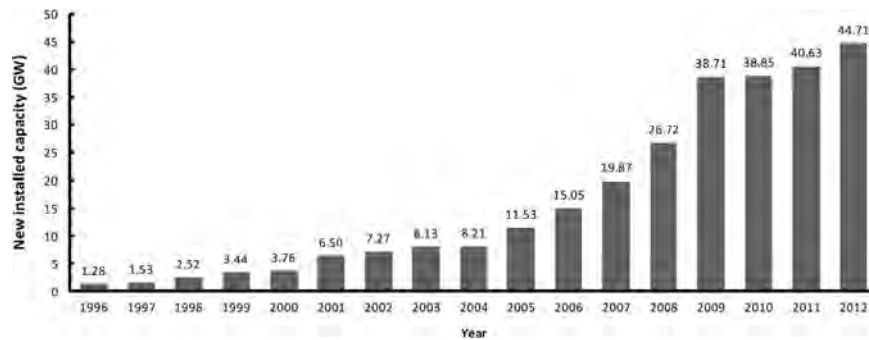


Fig. 1. Global annual installed wind capacity 1996–2012 [3].

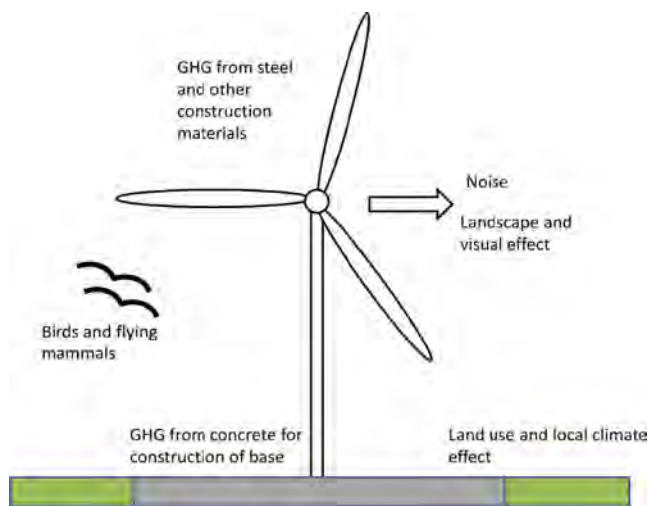


Fig. 2. Environmental impacts of wind power.

processes involved in the whole wind energy chain (raw materials procurement, construction, conversion to energy services, etc.) which will generate environmental impacts that affect the atmosphere, soil, water and living organisms. This review will collate information for use in the development of sustainable energy technologies and identify gaps in the study of environmental impacts of wind power as well as offer informative implications for policy makers. Noise pollution, bird and bat fatalities, greenhouse gas (GHG) emissions and local climate are the most significant environmental impacts, and are therefore the focus of this paper (Fig. 2).

2. Environmental impact assessment

The development of wind power will cause land use change and modify landscape settings, which will impact upon the living space, biological system and regional earth surface system, including noise pollution, bird and bat fatalities, GHGs and surface climate. Understanding these impacts will enable better mitigation and the creation of more effective renewable energy policies.

2.1. Noise pollution

Noise is defined as any unwanted sound. Wind turbines generate two types of noise: mechanical and aerodynamic. The mechanical noise is generated by the turbine's mechanical and electrical parts, while the aerodynamic noise is generated by the interaction of blades with the air (Fig. 3). The noise emission from wind turbine is a combination of both. Recently, due to the emergence of advanced mechanical design (e.g. proper insulation to prevent mechanical noise from proliferating outside the nacelle or tower, vibration damping), the mechanical noise has been reduced effectively, and is no longer considered to be as important as the aerodynamic noise, especially for utility scale wind turbines.

There are two main types of methods to measure the noise emissions from wind turbine. One is to use prediction models like semi-empirical models [10], and the other is to follow the international standards and/or International Environmental Agency (IEA) recommendations, with the help of devices such as IEA A-weighting. Recently, the prediction models have been more extensively developed. The most popular semi-empirical model is the one developed by Brooks et al. [11] which is derived by fitting a scaling law of Ffowcs Williams and Hall to the wind tunnel measurements of noise from two-dimensional NACA0012 aerofoil. However, the measurement of noise emissions from wind turbines is difficult: although several semi-empirical models have been designed, these models either are rather simplistic or make use of complex computational fluid dynamics solvers, and their application is rather time-consuming [10]; international standards and

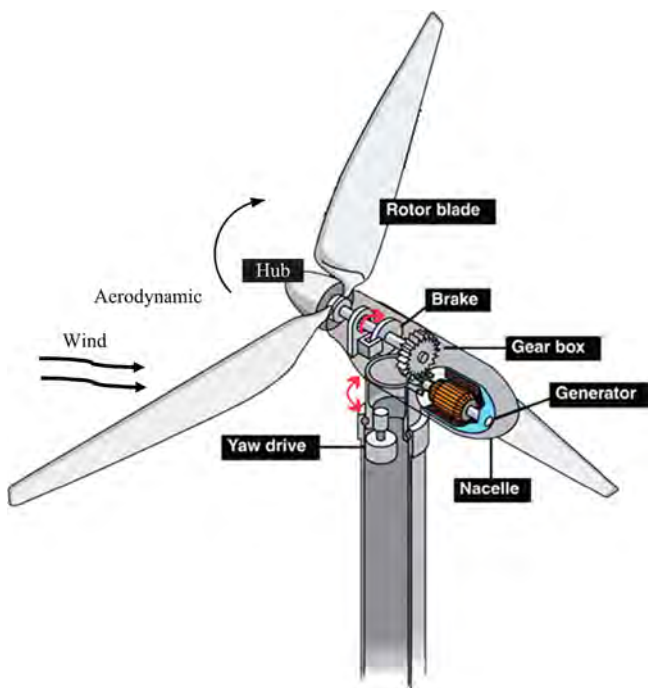


Fig. 3. Wind turbine noise sources. The mechanical noise includes the noise from hub, rotor blade, brake, gear box, generator, nacelle and yaw drive. The figure is adapted from Kunz et al. [2].

Table 1
Bird fatality of wind power.

Region	Fatality	Reference
Vansycle Oregon-USA	10 fatalities per year	[21]
Klondike Oregon-USA	8 fatalities per year	[21]
Foot Creek Rim, Wyoming-USA	35 avian per year	[21]
West Virginia-USA	118 avian per year	[21]
Nine Canyon, Washington-USA	36 fatalities per year	[21]
Buffalo Ridge, Minnesota-USA	14 deaths per year	[21]
Four eastern states in the US	0.003% of anthropogenic bird deaths per year	[22]
Altamont Pass, California-USA	0.02 to 0.15 collisions per turbine per year	[23]
United States	440,000 mortality per year	[24]
Navarra, Spain	0.1–0.6 collisions per turbine per year	[23]
Tarifa, Spain	0.02–0.15 collisions per turbine per year	[23]

guidelines about noise measurement have been designed for industrial sources, and are not always applicable to the measurement of noise emissions from wind turbines, mainly due to the fact that measurements are carried out in windy conditions (i.e. an issue outside the scope of standards dealing with noise measurements from industrial plants). The measurement of noise from wind turbines is influenced by the background noise (e.g. traffic on nearby roads and rail tracks). In many cases, it is difficult to measure sound pressure levels from modern wind turbines at wind speeds around 8 m s^{-1} or above, because the noise from the wind itself or background sounds may generally mask the turbine noise completely [12,13]. At lower wind speeds (e.g. $4\text{--}6 \text{ m s}^{-1}$) the noise from a wind turbine is more noticeable, since wind is strong enough to turn the blades but is not itself very noisy. Kaldellis et al. [10] reported that at 5.1 m s^{-1} wind speed at 10 m height, the noise from wind turbines was $48.5 \pm 1.6 \text{ dB}$, approximately 9 dB more than the ambient sound.

Noise may have an effect on the fatality of species (see Subsection 2.3). Some bat species are known to orient toward distant audible sounds [14] and they could thereby be attracted to the sounds generated by the rotating blades, but there is no data to confirm this. Bats may also be attracted to the ultrasonic noise produced by wind turbines [15]. Observations using thermal infrared imaging suggest that bats do fly and feed in close proximity to wind turbines [2,16].

2.2. Bird fatality

Although wind power is generally considered environmentally friendly, the development of wind power has been associated with the death of birds colliding with turbines and other wind plant structures. Due to lack of understanding of the level of avian use at areas, some of early wind powers installations in the US caused relatively high risk of turbine collisions, because these facilities were located regions where birds were abundant [17]. Due to the development of standardized methods for siting wind power [18] and monitoring for avian impacts [19,20], many new developments have reduced the risk of turbine collisions. The bird fatalities range from 8–118 birds per year or 0.02–0.6 collisions per turbine per year (Table 1)[21–24]. Raptors are found being more susceptible than other species. The European Wind Energy Association (EWEA) [23] reported that raptors showed some of the highest levels of mortality in both Altamont Pass, California, and Tarifa, Spain; this is due to their dependence on thermals to gain altitude, to move between locations and to forage. Some of them are long-lived species with low reproductive rates and thus more vulnerable to loss of individuals by collisions. Raptors are most affected (78.2%) during spring, followed by migrant passerines during post-breeding migration (September/October) [23]. Other species reported include Eurasian griffon (*Cypus fulvus*), Kestrel (*Falco tinnunculus*), Short-toed eagle (*Circus gallicus*) and Black kite (*Milvus migrans*). Barrios

and Rodriguez [25] reported that the fatalities for Eurasian griffon (*Cypus fulvus*) were 0.12 per turbine per year, 0.14 per turbine per year for Kestrel (*Falco tinnunculus*), 0.008 per turbine per year for Short-toed eagle (*Circus gallicus*) and 0.004 per turbine per year for Black kite (*Milvus migrans*), respectively. There is, however, uncertainty in bird fatality measurements which have to be adjusted upwards, as scavengers are known to remove bird carcasses before researchers could discover them and researchers may miss carcasses, especially in agricultural landscapes and dense forest ridge tops [26–28].

The avian mortalities of wind farms are very dependent on the season, weather, specific site (e.g. mountain ridge or migration route), topography, species (large and medium versus small, and migratory versus resident), type of bird activity (e.g. nocturnal migrations and movements from and to feeding areas), layout of the wind farm and type of wind technology [23,24,29]. The main factors which determine the mortality of birds by collision in wind farms include landscape topography, direction and strength of local winds, turbine design characteristics, and the specific spatial distribution of turbines on the location [23,29]. However, it is still unclear how these factors impact the avian mortalities of wind farm and therefore efforts to understanding these are still needed.

2.3. Bat fatality

Bats will be killed by wind farms, especially by utility-scale wind energy facilities. Bat fatalities are reported to be relatively small before 2001 [30]. This is largely because most monitoring studies are designed specifically for bird fatality assessment and therefore bat fatalities are likely underestimated [19,26]. Recent monitoring studies indicate that large numbers of bat fatalities have been observed at utility-scale wind energy facilities, especially along forested ridgetops in the eastern US [2,21,30–32], and in agricultural regions of southwester Alberta, Canada (Table 2) [32–49]. Similar bat fatalities have been reported at wind energy facilities in Europe [50]. The number of bats killed by wind energy facilities installed along forested ridgetops in the eastern US is reported ranging from 15.3 to 53.3 bats per MW per year, and the bat fatalities reported in southwester Alberta, Canada, are comparable to those found at wind energy facilities installed along the forested regions of the eastern US [2]. The bat fatalities at the Buffalo mountain site are reported as 53.3 bats per MW per year at 3 small (0.66 MW) Vestas V47 wind turbines (Vestas Wind Systems A/S, Ringkøbing, Denmark) and 38.7 bats per MW per year at 15 larger (1.8 MW) Vestas V80 wind turbines [32]. The bat fatalities at Lewis County, New York, are estimated ranging from 12.3 bats to 17.8 bats per MW per year at 1.65 MW Vestas wind turbines, depending on carcass search frequency [41]. Bat fatalities from regions of the western and mid-western US are relatively

Table 2
Bat fatality of wind power, modified from Kunz et al. [2].

Region	Fatality (MW ⁻¹ year ⁻¹)	Reference
Buffalo Mountain, TN I-USA	31.5	[33]
Buffalo Mountain, TN II-USA	41.1	[32]
Buffalo Mountain with small Vestas V47 wind turbines-USA	53.3	[32]
Buffalo Mountain with large Vestas V80 wind turbines-USA	38.7	[32]
Buffalo Ridge, MN I-USA	0.8	[34]
Buffalo Ridge, MN II (1996–1999)–USA	2.5	[35]
Buffalo Ridge, MN II (2001–2002)–USA	2.9	[36]
Foot Creek Rim, WY-USA	2.0	[37,38]
High Winds, CA-USA	2.0	[39]
Klondike, OR-USA	0.8	[40]
Lewis County, New York-USA	12.3–17.8	[41]
Lincoln, WI-USA	6.5	[42]
Meyersdale, PA-USA	15.3	[43]
Mountaineer, WV (2003)–USA	32.0	[44]
Mountaineer, WV (2004)–USA	25.3	[43]
Nine Canyon, WA-USA	2.5	[45]
Oklahoma Wind Energy centre, OK-USA	0.8	[46]
Stateline, OR/WA-USA	1.7	[47]
Top of Iowa, IA-USA	8.6	[48]
Vansycle, OR-USA	1.1	[49]
Southwestern Alberta, Canada	15.3–41.1	[2]

low, ranging from 0.8 to 8.6 bats per MW per year. This could be because many of these studies were designed only to assess bird fatalities [19]. Like bird fatalities, bat fatalities may be underestimated, since scavengers can remove carcasses before researchers are able to recover them [26].

Bat fatalities of wind power vary not only with location, topography, layout of the wind farm and type of wind technology, but also with species and other factors. Bat species that migrate long distance are those most commonly killed at utility-scale wind energy facilities in the US [2]. In North America, foliage-roosting, eastern red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*) and tree cavity-dwelling silver-haired bats (*Lasionycteris noctivagans*), each of which migrate long distances, are identified at wind energy facilities [2]. Other bat species killed by wind turbine in the US include the western red bat (*Lasiurus blossevilli*), Seminole bat (*Lasiurus seminolus*), eastern pipistrelle (*Perimyotis [=Pipistrellus] subflavus*), little brown myotis (*Myotis lucifugus*), northern long-eared myotis (*Myotis septentrionalis*), long-eared myotis (*Myotis evotis*), big brown bat (*Eptesicus fuscus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*) [2].

Bats are struck and killed by the turning rotor blades of wind turbines, and the factors increasing risk include the increasing height of wind turbines, the modifications of landscapes during installation of wind energy facilities, including the construction of roads and power-line corridors and removal of trees to create clearings, the sound produced by wind turbines (though no evidence), the complex electromagnetic fields in the vicinity of nacelles produced by wind turbines, and weather conditions like low wind speed at night [2]. It is, however, unclear why these factors increase the risk to bats. Potential explanations include: (1). The increase in height of wind turbine enlarges the danger area for bat and therefore increases the possibility of a bat, who migrates or forages at higher altitudes, touching the wind blades. (2). The modifications of landscapes may attract more bats around wind turbines, due to the creation of favourable environment for aerial insects upon which most insectivorous bats feed. (3). Some bats may be acoustically oriented or disoriented. (4). Some bats use receptors to guide fly. The complex electromagnetic field produced by wind turbines will interfere with perception in receptors. (5). The weather conditions such as cool and foggy conditions in valleys may make bats active along ridgetops, which will increase the likelihood of striking the moving wind turbine blades.

2.4. Greenhouse Gas Emissions

Wind power mitigates GHG emissions if the energy produced displaces fossil fuels, but some GHGs are also emitted; most of which arise from the production of concrete and steel for wind turbine foundations. Life-cycle analysis (LCA) is always used to assess the life-cycle GHG emissions from wind power, because it takes into account the whole life from-cradle-to-grave (i.e. from raw material extraction through material processing to disposal or recycling). The LCA shows that the GHG emissions from wind power range from 2 to 86 g CO₂e/kW h (Table 3) [51–56]. The large variability in the estimation of GHG emissions is mainly due to the size of wind farm, the methods used to estimate GHG emissions from the life cycle of wind farm, and locations. For example, Wiedmann et al. [52] reported that the life-cycle GHG emissions from 2 MW wind turbine were 13.4 g CO₂e/kW h using a process-based LCA, 28.7 g CO₂e/kW h using an integrated hybrid LCA (which linked the inputs of goods to processes to technology matrix derived from financial transactions between economic sectors) and 29.7 g CO₂e/kW h using an InputOutput-based hybrid LCA approach (which approximated the actual input requirements of the desired wind power subsector by using information from process analysis). In this estimation, the two hybrid LCAs produce higher figures than the process-based LCA. This is because the process-based LCA truncates inputs from higher upstream production processes when setting the system boundaries.

2.5. Land surface impacts

When wind turbines operate, they generate turbulence in their wakes. The turbulence is small-scale, chaotic almost-random air movement and will modify the vertical mixing of lower and upper level air. The modification of vertical mixing of lower and upper level air has different impacts on the regional land surface for during the day and at night. The turbulence wakes mix cool air down and warm air up during the day, and mix warm air down and cool air up at night. This raises the surface temperature at night, but may have no significant impact on surface temperature during the day, because during the day the large daytime mixing due to solar heating offsets the cooling produced by turbulent. The modification of vertical mixing of lower and upper level air may impact the cloud formation and hence the local precipitation.

Table 3
GHG emissions from wind power with LCA.

Wind farm size	GHG emissions [g CO ₂ e/kW h]	Reference
250 W wind turbine	46.4	[51]
2 MW wind turbine	28.7	[52]
2 MW wind turbine	13.4	[52]
2 MW wind turbine	29.7	[52]
2 MW wind turbine	6.6	[53]
4.5 MW wind turbine	15.8	[51]
Wind turbines in Brazil and Germany	2–81	[54]
Offshore wind power in coastal Germany	45	[54]
–	15–25	[55]
–	9.7–123.7	[56]

Therefore, while converting wind's kinetic energy into electricity, wind turbines modify surface-atmosphere exchanges and the transfer of energy, momentum, mass and moisture within the atmosphere (Fig. 4). These changes may have noticeable impacts on local to regional weather and climate if spatially large enough. Observations with satellite data shows a significant warming trend of up to 0.72 °C per decade, particularly at night-time, over wind farms relative to nearby non-wind-farm regions [57]. However, studies for the impacts of wind power on land surface exchanges are relatively new, and better effort to understand these impacts is needed.

3. Discussion

Wind power is regarded as a promising renewable energy, and is growing rapidly worldwide. However, the deployment of wind power depends to a considerable degree on its environmental performance, and needs critical consideration. Although the deployment of wind power does cause noise emissions, the noise emissions from wind farm are smaller than those from city traffic (Table 4) [58]. Noise emissions of wind farm can be further reduced through design of wind turbines, and careful location and planning of wind farms.

The bird fatality resulting from wind power is also rather small. Evidences show that it is smaller than other energy industries, or other-made structures such as power lines, in the US (Table 5) [24,59,60]. Such small bird fatality would not cause the serious loss of the richness of species, at global and local scales. However, there is no assessment for the overall environmental impacts of wind power, and comparisons between wind power and other energy technologies, such as fuel, are rare, but would be of great benefit to policy makers.

Generating electricity from wind energy reduces the consumption of fossil fuels, and therefore results in GHG emission savings. A study conducted by Irish national grid found that the reductions in CO₂ emissions, due to fossil fuel displacement by wind energy, range from 0.36 to 0.59 t CO₂ per MW h [61]. GWEC [62] reports that the 97 GW of wind energy capacity installed at the end of 2007 will save 122 million tonnes of CO₂ every year, helping to combat climate change. Embedded GHG in turbine construction is therefore very small compared to the GHG mitigated through fossil fuel displacement. Carbon payback times on mineral soils can be extremely short, though the payback time on peatlands can be longer due to the carbon potentially lost from the peats during construction [63,64].

While the deployment of wind power will produce lower noise pollution levels than other ambient noises of human activity, generate far lower bird and bat fatalities than other human activities, and mitigate the GHG emissions, it may

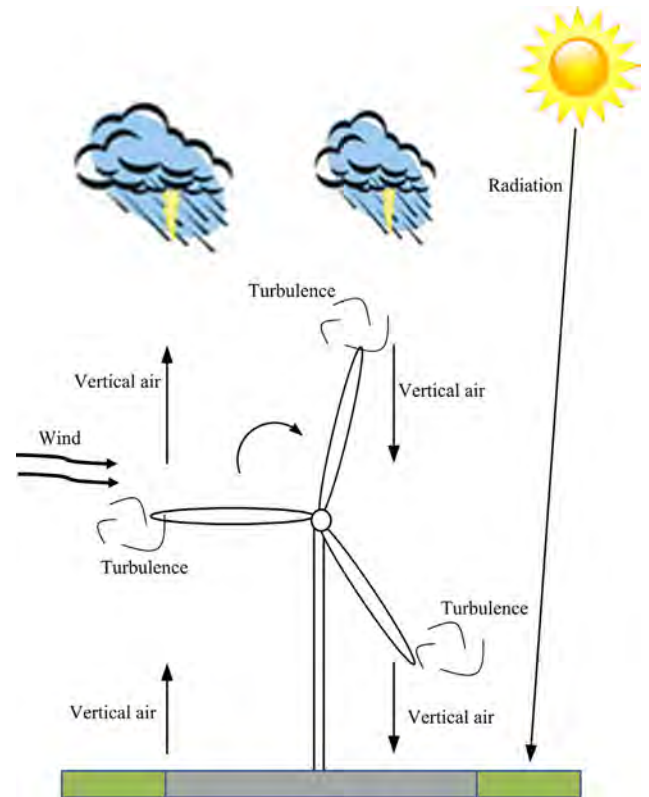


Fig. 4. Physical processes between wind power and surface-atmosphere.

Table 4
Comparative noise for common activities [58].

Source/activity	Indicative noise level (dB)
Threshold of hearing	0
Rural night-time background	20–40
Quiet bedroom	35
Wind farm at 350 m	35–45
Busy road at 5 km	35–45
Car at 65 km/h at 100 m	55
Busy general office	60
Conversation	60
Truck at 50 km/h at 100 m	65
City traffic	90
Pneumatic drill at 7 m	95
Jet aircraft at 250 m	105
Threshold of pain	140

generate noticeable impacts on local to regional weather and climate if the area of turbines is large enough. The noticeable impacts may offset the benefits from the lower noise pollution levels, lower bird and bat fatalities, and mitigation of GHG emissions. This again calls for overall assessment of environmental impacts of wind power. Therefore, before the large deployment of wind power, more monitoring experiments, specifically for the overall assessment of environmental impacts, are still needed, in order to obtain the sustainable desirable renewable energy sources. The monitoring experiments should be designed to take into account the location, layout and size of wind farm, and type of wind technologies.

The environmental impacts of wind power will interact each other. For example, noise may have an effect on the fatality of species. However, the mechanism of interaction among these impacts is still unclear. Due to this, the review for the interaction among these impacts is excluded. Nevertheless, understanding the

Table 5
Avian mortality in the United States.

Item	Estimated mortality per year (in thousands)	Reference
Wind turbines	440	[24]
Aircraft	80	[59]
Nuclear powerplants	330	[24]
Large Communications Towers (over 180', North America)	6,800	[60]
Communication towers (cellular, radio, microwave)	4,000–50,000	[24]
Fossil fuel powerplants	14,000	[24]
Cars and trucks	50,000–100,000	[24]
Agriculture	67,000	[24]
Pesticide use	72,000	[24]
Building windows	97,000–976,000	[24]
Domestic cats	100,000	[24]
Hunting	100,000	[24]
Feral cats	110,000	[24]
Transmission lines (conventional powerplants)	175,000	[24]

mechanism of interaction among these impacts will contribute to mitigate the adverse environmental impacts of wind power, and would be an interesting topic in the future research.

Acknowledgements

The study was supported by the UK Energy Research Centre (UKERC), United Kingdom (Grant no. NE/G007748/1) award: 'Integrated approaches to ecosystem services and energy: assessing the global and local impacts on ecosystem services of energy provision in the UK'. We gratefully acknowledge the helpful comments from Pete Smith (University of Aberdeen, UK) and the anonymous referees.

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ATTACHMENT E:

Ana Teresa Marques et al., *Understanding Bird Collisions at Wind Farms: An Updated Review on the Causes and Possible Mitigation Strategies*, 179 BIOLOGICAL CONSERVATION 40 (2014)



Review

Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies



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ARTICLE INFO

Article history:

Received 17 April 2014

Received in revised form 20 August 2014

Accepted 27 August 2014

Available online 19 September 2014

Keywords:

Bird fatality

Collision risk

Wind turbines

Mitigation

Minimization

Causes of collision

ABSTRACT

Bird mortality due to collisions with wind turbines is one of the major ecological concerns associated with wind farms. Data on the factors influencing collision risk and bird fatality are sparse and lack integration. This baseline information is critical to the development and implementation of effective mitigation measures and, therefore, is considered a priority research topic. Through an extensive literature review (we compiled 217 documents and include 111 in this paper), we identify and summarize the wide range of factors influencing bird collisions with wind turbines and the available mitigation strategies. Factors contributing to collision risk are grouped according to species characteristics (morphology, sensorial perception, phenology, behavior or abundance), site (landscape, flight paths, food availability and weather) and wind farm features (turbine type and configuration, and lighting). Bird collision risk results from complex interactions between these factors. Due to this complexity, no simple formula can be broadly applied in terms of mitigation strategies. The best mitigation option may involve a combination of more than one measure, adapted to the specificities of each site, wind farm and target species. Assessments during project development and turbine curtailment during operation have been presented as promising strategies in the literature, but need further investigation. Priority areas for future research are: (1) further development of the methodologies used to predict impacts when planning a new facility; (2) assessment of the effectiveness of existing minimization techniques; and (3) identification of new mitigation approaches.

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1. Introduction

Wind energy generation has experienced rapid worldwide development over recent decades as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur et al., 2011). However, bird fatalities due to collisions with wind turbines¹ (WT) have been consistently identified as a main ecological drawback to wind energy (Drewitt and Langston, 2006).

Collisions with WT appear to kill fewer birds than collisions with other man-made infrastructures, such as power lines, buildings or even traffic (Calvert et al., 2013; Erickson et al., 2005). Nevertheless, estimates of bird deaths from collisions with WT worldwide range from 0 to almost 40 deaths per turbine per year (Sovacool, 2009). The number of birds killed varies greatly between sites, with some sites posing a higher collision risk than others, and with some species being more vulnerable (e.g. Hull et al., 2013; May et al., 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino et al., 2013; Erickson et al., 2005; Huso and Dalthorp, 2014). Additionally, even for low fatality rates, collisions with WT may have a disproportionate effect on some species. For long-lived species with low productivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (e.g. Carrete et al., 2009; De Lucas et al., 2012a; Drewitt and Langston, 2006). The situation is even more critical for species of conservation concern, which additionally sometimes suffer the highest collision risk (e.g. Osborn et al., 1998).

High bird fatality rates at several wind farms² (WF) have raised concerns among the industry and scientific community. High profile examples include the Altamont Pass Wind Resource Area³ (APWRA) in California because of high fatality of Golden eagles (*Aquila chrysaetos*), Tarifa in Southern Spain for Griffon vultures (*Gyps fulvus*), Smøla in Norway for White-tailed eagles (*Haliaeetus albicilla*), and the port of Zeebrugge in Belgium for gulls (*Larus* sp.) and terns (*Sterna* sp.) (Barrios and Rodríguez, 2004; Drewitt and Langston,

2006; Everaert and Stienen, 2008; May et al., 2012a; Thelander et al., 2003). Due to their specific features and location, and characteristics of their bird communities, these WF have been responsible for a large number of fatalities that culminated in the deployment of additional measures to minimize or compensate for bird collisions. However, currently, no simple formula can be applied to all sites; in fact, mitigation measures must inevitably be defined according to the characteristics of each WF and the diversity of species occurring there (Hull et al., 2013; May et al., 2012b). A deep understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures.

Due to the increasing number of studies, particularly those implementing a Before-After-Control-Impact (BACI) study design, our knowledge of the interactions between birds and WT has increased immensely compared to the early stages of the wind energy industry. However, despite the fact that the impacts of avian collisions with WT have been extensively reviewed (e.g. Drewitt and Langston, 2006; Everaert and Stienen, 2008), information on the causes of bird collisions with WT remains sparse and is often compiled in technical reports that are not readily accessible (Northrup and Wittemyer, 2013). To our knowledge, the review on avian fatalities due to collisions with man-made structures by Drewitt and Langston (2008) was the first major attempt to compile information that, until then, was scattered across many peer-reviewed articles and gray literature. However, it focused on different types of structures, and collisions with WF were only alluded to. Moreover, new questions regarding WF have emerged and valuable research has been conducted on the topic that requires a new and extensive review of bird interactions with WT.

Here, we update and review the causes of bird fatalities due to collisions with WT at WF, including the most recent findings and considering species-specific, site-specific and WF-specific factors. We discuss how this information may be used when planning and managing a WF, based on a mitigation hierarchy that includes avoidance, minimization and compensation strategies (Langston and Pullan, 2003). We also highlight future research needs.

2. Methods

We reviewed a wide range of peer-reviewed and non-peer-reviewed articles, technical reports and conference proceedings

¹ Wind Turbine – WT.

² Wind Farm – WF.

³ Altamont Pass Wind Resource Area – APWRA.

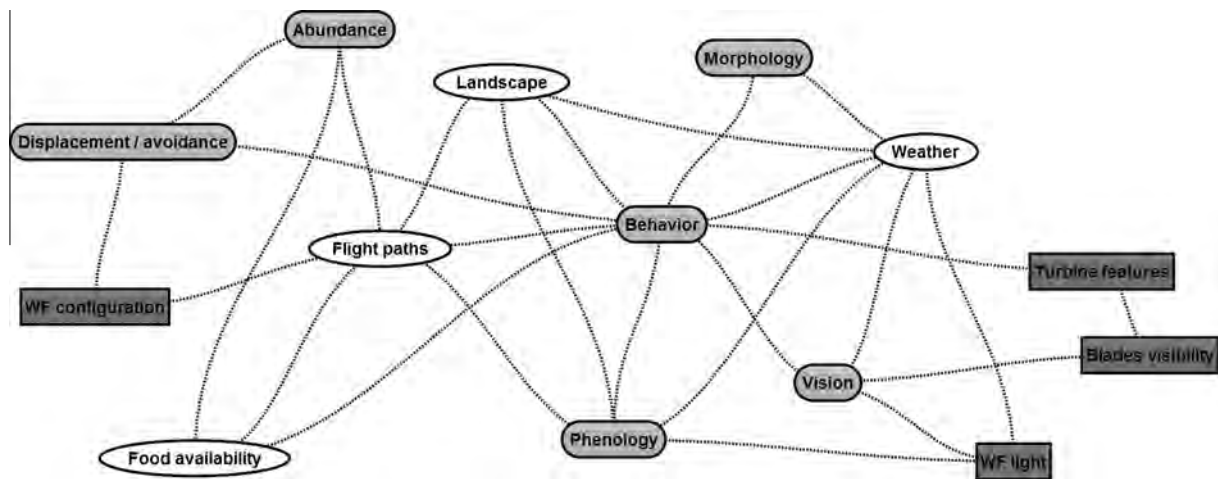


Fig. 1. Relationships between the species-specific (round/gray), site-specific (elliptical/white) and wind farm-specific (square/dark) factors influencing bird collision risk with WT.

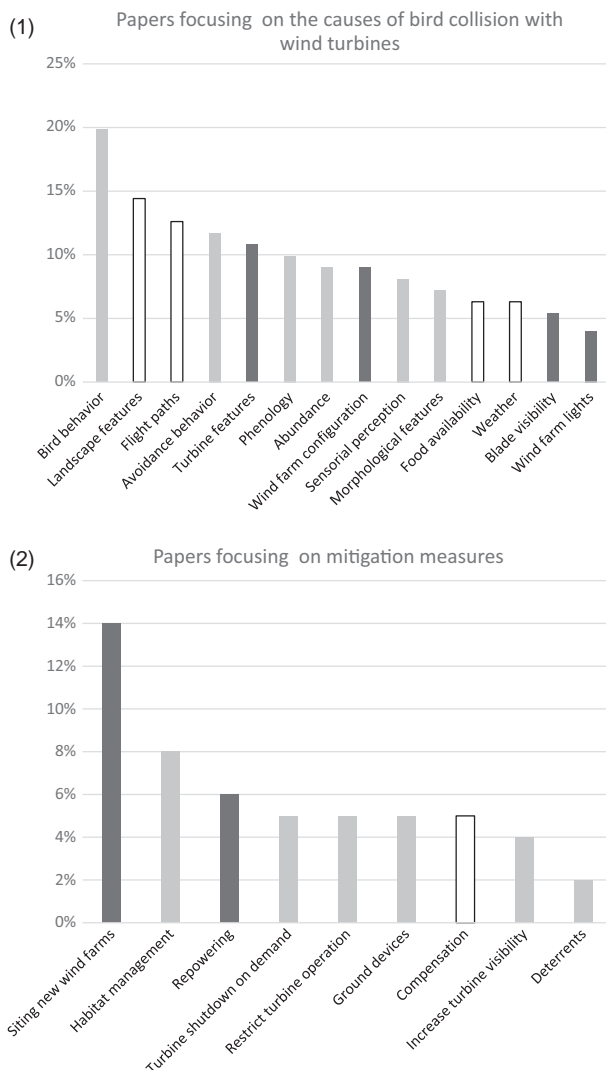


Fig. 2. Percentage of studies that mention: (1) factors influencing bird collisions with wind turbines: species-specific (gray), site-specific (white) and wind farm-specific (dark) and (2) different strategies to mitigate bird collision: avoidance (dark), minimization (gray) and compensation (white).

on topics related to bird fatalities at WF. The literature was found by means of search engines (Web of Knowledge and Google Scholar), conferences and workshops. Beginning with the more general topic of bird fatalities at WF, we refined our search with key phrases such as “bird collision”, “collision with turbines”, “causes of collision”, “morphology” (particularly “wing-loading”), “flight type”, “behavior”, “vision”, “hearing”, “flight patterns”, “weather”, “landscape features”, “migration routes”, “offshore features”, and wind farm features such as “scale”, “configuration”, “layout”, “lights”, “visibility”, “turbine size”, “turbine height”, and “mitigation”, “avoidance”, “minimization” and “compensation”. Due to the vast amount of technical information available, we did not limit our search to the use of a few specific keywords, but we tried several possible combinations to perform an extensive search of the literature on each sub-topic. In total we compiled 217 documents and from those we reference 111 in our paper, 90 regarding bird interacting with WF. We selected a subset of literature presenting (1) evidences based on experimental designs rather than inferences; (2) studies considering different types of birds communities and geographic areas; (3) emphasizing the peer-reviewed studies, when the information was overlapping between documents; and (4) the most recent findings on the subject (60% of the documents considered were published on 2008 or later, after the most recent previous review of this topic).

The studies we found may provide a non-random representation of all data collected regarding this area of research, as not all the documents produced are made publicly available. The data presented are geographically biased, favoring countries that have already had wind energy for more than a decade and with larger investments in wind energy developments, but also those with larger resources to assure monitoring programs and research. Therefore, 60% of the papers regarding WF referenced are from Europe (mainly Spain and UK) and 33% from USA.

We only summarize the aspects relating to WT themselves. Complementary structures at WF facilities, such as power lines or meteorological towers, were not included in order to ensure focused analysis and to keep our review as objective as possible.

3. Causes of bird collisions with wind turbines: factors influencing risk

We identified a wide range of factors influencing bird collisions with WT. Although we examine each factor individually below for simplicity, they are interconnected. To represent these connections,

we graphically outline the complex relationships between the explanatory variables of bird collisions in Fig. 1. While we could not identify one particular factor as being the main cause of bird collisions due to these strong interactions, we can group the factors into three main categories: species-, site- and WF-specific. Fig. 2 represents the number of papers that refer or test the importance of each factor, showing that bird behavior is the factor more frequently reported in the literature.

3.1. Species-specific factors

3.1.1. Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and WT. The most likely reason for this is that large birds often need to use thermal and orographic updrafts to gain altitude, particularly for long distance flights. Thermal updrafts (thermals) are masses of hot, rising wind that form over heated surfaces, such as plains. Being dependent on solar radiation, they occur at certain times of the year or the day. Conversely, orographic lift (slope updraft), is formed when wind is deflected by an obstacle, such as mountains, slopes or tall buildings. As such they are formed depending on wind strength and terrain topography. Soaring birds use these two types of lift to gain altitude (Duerr et al., 2012).

Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wing span squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas et al., 2008; Herrera-Alsina et al., 2013; Janss, 2000). Birds with high wing loading, such as the Griffon vulture, seem to collide more frequently with WT at the same sites than birds with lower wing loadings, such as Common buzzards (*Buteo Buteo*) and Short-toed eagles (*Circaetus gallicus*), and this pattern is not related with their local abundance (Barrios and Rodríguez, 2004; De Lucas et al., 2008). Hence, this is probably because species with a high wing-loading need to rely more on the use of updrafts to gain altitude and to soar, particularly for long-distance flights, compared to species with lower wing-loading that tend to use the metabolically less efficient flapping (Mandel et al., 2008). High wing-loading is also associated with low flight maneuverability (De Lucas et al., 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

3.1.2. Sensorial perception

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson et al., 2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld et al., 2009).

The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to collisions, such as Griffon vultures and African vultures (*Gyps africanus*) (Martin and Katzir, 1999; Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke et al., 2010). Furthermore, for some species, their high resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g. Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke et al., 2010). Finally, some birds tend to look downwards when in flight, searching for

conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin and Shaw, 2010; Martin, 2011). For example, the visual fields of Griffon vultures and African vultures include extensive blind areas above, below and behind the head and enlarged supra-orbital ridges (Martin et al., 2012). This, combined with their tendency to angle their head toward the ground in flight, might make it difficult for them to see WT ahead, which might at least partially explain their high collision rates with WT compared to other raptors (Martin, 2012).

Currently, there is little information on whether noise from WT can play a role in bird collisions with WT. Nevertheless, WT with whistling blades are expected to experience fewer avian collisions than silent ones, with birds hearing the blades in noisy (windy) conditions. However, the hypothesis that louder blade noises (to birds) result in fewer fatalities has not been tested so far (Dooling, 2002).

3.1.3. Phenology

It has been suggested that resident birds would be less prone to collision, due to their familiarity with the presence of the structures (Drewitt and Langston, 2008). However, recent studies have shown that, within a WF, raptor collision risk and fatalities are higher for resident than for migrating birds of the same species. An explanation for this may be that resident birds generally use the WF area several times while a migrant bird crosses it just once (Krijgsveld et al., 2009). However, other factors like bird behavior are certainly relevant. Katzner et al. (2012) showed that Golden eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes, where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes. Also, Johnston et al. (2014) found that during migration when visibility is good Golden eagles can adjust their flight altitudes and avoid the WT.

At two WF in the Strait of Gibraltar, the majority of Griffon vulture deaths occurred in the winter. This probably happened because thermals are scarcer in the winter, and resident vultures in that season probably relied more on slope updrafts to gain lift (Barrios and Rodríguez, 2004). The strength of these updrafts may not have been sufficient to lift the vultures above the turbine blades, thereby exposing them to a higher collision risk. Additionally, migrating vultures did not seem to follow routes that crossed these two WF, so the number of collisions did not increase during migratory periods. Finally, at Smøla, collision risk modeling showed that White-tailed eagles are most prone to collide during the breeding season, when there is increased flight activity in rotor swept zones (Dahl et al., 2013).

The case seems to be different for passerines, with several studies documenting high collision rates for migrating passerines at certain WF, particularly at coastal or offshore sites. However, comparable data on collision rates for resident birds is lacking. This lack of information may result from fewer studies, lower detection rates and rapid scavenger removal (Johnson et al., 2002; Lekuona and Ursua, 2007). One of the few studies reporting passerine collision rates (from Navarra, northern Spain) documents higher collision rates in the autumn migration period, but it is unclear if this is due to migratory behavior or due to an increase in the number of individuals because of recently fledged juveniles (Lekuona and Ursua, 2007). Another study, at an offshore research platform in Helgoland, Germany, recorded disproportionate rates of collision (almost 2 orders of magnitude) for nocturnal migratory passerines compared to non-passerines (Hüppop et al., 2006).

3.1.4. Bird behavior

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight, which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed hawks (*Buteo jamaicensis*) at APWRA (Hoover and Morrison, 2005). The hovering behavior exhibited by Common kestrels (*Falco tinnunculus*) when hunting may also explain the fatality levels of this species at WF in the Strait of Gibraltar (Barrios and Rodríguez, 2004). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of WT position (Krijgsveld et al., 2009; Smallwood et al., 2009).

Collision risk may also be influenced by behavior associated with a specific sex or age. In Belgium, only adult Common terns (*Sterna hirundo*) were impacted by a WF (Everaert and Stienen, 2007) and the high fatality rate was sex-biased (Stienen et al., 2008). In this case, the WF is located in the foraging flight path of an important breeding colony, and the differences between fatality of males and females can be explained by the different foraging activity during egg-laying and incubation (Stienen et al., 2008). Another example comes from Portugal, where recent findings showed that the mortality of the Skylark (*Alauda arvensis*) is sex and age biased, affecting mainly adult males. This was related with the characteristic breeding male song-flights that make birds highly vulnerable to collision with wind turbines (Morinha et al., 2014).

Social behavior may also result in a greater collision risk with WT due to a decreased awareness of the surroundings. Several authors have reported that flocking behavior increases collision risk with power lines as opposed to solitary flights (e.g. Janss, 2000). However, caution must be exercised when comparing the particularities of WF with power lines, as some species appear to be vulnerable to collisions with power lines but not with WT.

Several collision risk models incorporate other variables related to bird behavior. Flight altitude is widely considered important in determining the risk of bird collisions with offshore and onshore WT, as birds that tend to fly at the height of rotor swept zones are more likely to collide (e.g. Band et al., 2007; Furness et al., 2013; Garthe and Hüppop, 2004).

For marine birds, the percentage of time flying and the frequency of time flying during the night period have also been used as indicators of vulnerability to collision, since birds that spend more time flying, especially at night, are more likely to be at risk of collision with WT (Furness et al., 2013; Garthe and Hüppop, 2004). This factor varies seasonally, perhaps because flight activity increases during the chick rearing and breeding seasons or because of a peak of flight activity during migration (Furness et al., 2013).

3.1.5. Avoidance behaviors

Collision fatalities are also related to displacement and avoidance behaviors, as birds that do not exhibit either of these behaviors are more likely to collide with WT. The lack of avoidance behavior has been highlighted as a factor explaining the high fatality of White-tailed eagles at Smøla WF, as no significant differences were found in the total amount of flight activity within and outside the WF area (Dahl et al., 2013). However, the birds using the Smøla WF are mainly subadults, indicating that adult eagles are being displaced by the WF (Dahl et al., 2013).

Two types of avoidance have been described (Furness et al., 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire WF (e.g. Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patracá et al., 2014), and

'micro-avoidance' whereby birds enter the WF but take evasive actions to avoid individual WT (Band et al., 2007).

Displacement due to WF, which can be defined as reduced bird breeding density within a short distance of a WT, has been described for some species (Pearce-Higgins et al., 2009). Birds exhibiting this type of displacement behavior when defining breeding territories are less vulnerable to collisions, not because of morphological or site-specific factors, but because of altered behavior.

3.1.6. Bird abundance

To date, research on the relationship between bird abundance and fatality rates has yielded distinct results. Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete et al., 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g. Ferrer et al., 2012; Hull et al., 2013). Instead, fatality rates depend on other factors such as differential use of specific areas within a WF (De Lucas et al., 2008). For example, at Smøla, White-tailed eagle flight activity is correlated with collision fatalities (Dahl et al., 2013). In the APWRA, Golden eagles, Red-tailed hawks and American kestrels (*Falco sparverius*) have higher collision fatality rates than Turkey vultures (*Cathartes aura*) and Common raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood et al., 2009), indicating that fatalities are more influenced by each species' flight behavior and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas et al., 2008).

3.2. Site-specific factors

3.2.1. Landscape features

Susceptibility to collision can also heavily depend on landscape features at a WF site, particularly for soaring birds that predominantly rely on wind updrafts to fly (see Sections 3.1.1 and 3.1.3). Some landforms such as ridges, steep slopes and valleys may be more frequently used by some birds, for example for hunting or during migration (Barrios and Rodríguez, 2004; Drewitt and Langston, 2008; Katzner et al., 2012; Thelander et al., 2003). In APWRA, Red-tailed hawk fatalities occur more frequently than expected by chance at WT located on ridge tops and swales, whereas Golden eagle fatalities are higher at WT located on slopes (Thelander et al., 2003).

Other birds may follow other landscape features, such as peninsulas and shorelines, during dispersal and migration periods. Kitano and Shiraki (2013) found that the collision rate of White-tailed eagles along a coastal cliff was extremely high, suggesting an effect of these landscape features on fatality rates.

3.2.2. Flight paths

Although the abundance of a species *per se* may not contribute to a higher collision rate with WT, as previous discussed, areas with a high concentration of birds seem to be particularly at risk of collisions (Drewitt and Langston, 2006), and therefore several guidelines on WF construction advise special attention to areas located in migratory paths (e.g. Atienza et al., 2012; CEC, 2007; USFWS, 2012).

As an example, Johnson et al. (2002) noted that over two-thirds of the carcasses found at a WF in Minnesota were of migrating birds. At certain times of the year, nocturnally migrating passerines are the most abundant species at WF, particularly during spring and fall migrations, and are also the most common fatalities (Strickland et al., 2011).

For territorial raptors like Golden eagles, foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2–3 km radius (McGrady et al., 2002). These results, combined with the terrain features selected by Golden eagles to forage such as areas closed to ridges, can be used to predict the areas used by the species to forage (McLeod et al., 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright et al., 2006).

WF located within flight paths can increase collision rates, as seen for the WF located close to a seabird breeding colony in Belgium (Everaert and Stienen, 2008). In this case, WT were placed along feeding routes, and several species of gulls and terns were found to fly between WT on their way to marine feeding grounds. Additionally, breeding adults flew closer to the structures when making frequent flights to feed chicks, which potentially increased the collision risk.

3.2.3. Food availability

Factors that increase the use of a certain area or that attract birds, like food availability, also play a role in collision risk. For example, the high density of raptors at the APWRA and the high collision fatality due to collision with turbines is thought to result, at least in part, from high prey availability in certain areas (Hoover and Morrison, 2005; Smallwood et al., 2001). This may be particularly relevant for birds that are less aware of obstructions such as WT while foraging (Krijgsveld et al., 2009; Smallwood et al., 2009).

Higher food density can strongly increase collision risk at offshore sites. For example, the “reef effect” whereby fish aggregate around offshore turbine foundations and submerged structures can attract piscivorous birds and increase collision probability with WT (Anderson et al., 2007).

3.2.4. Weather

Certain weather conditions, such as strong winds that affect the ability to control flight maneuverability or reduce visibility, seem to increase the occurrence of bird collisions with artificial structures (Longcore et al., 2013). Some high bird fatality events at WF have been reported during instances of poor weather. For example, at an offshore research platform in Helgoland, Germany, over half of the bird strikes occurred on just two nights that were characterized by very poor visibility (Hüppop et al., 2006). Elsewhere, 14 bird carcasses were found at two adjacent WT after a severe thunderstorm at a North American WF (Erickson et al., 2001). However, in these cases, there may be a cumulative effect of bad weather and increased attraction to artificial light.

Besides impairing visibility, low altitude clouds can in turn lower bird flight height, and therefore increasing their collision risk with tall obstacles (Langston and Pullan, 2003).

For WF located along migratory routes, the collision risk may not be the same throughout a 24-h period, as the flight altitudes of birds seem to vary. The migration altitudes of soaring birds have been shown to follow a typically diurnal pattern, increasing during the morning hours, peaking toward noon, and decreasing again in the afternoon, in accordance with general patterns of daily temperature and thermal convection (Kerlinger, 2010; Shamoun-Baranes et al., 2003).

Collision risk of raptors is particularly affected by wind. For example, Golden eagles migrating over a WF in Rocky Mountain showed variable collision risk according to wind conditions, which decreased when the wind speed raised and increased under head- and tailwinds when compared to western crosswinds (Johnston et al., 2014).

3.3. Wind farm-specific factors

3.3.1. Turbine features

Turbine features may play an important role in bird collision risk, but as such turbine features are often correlated, it is not possible to partition this risk according to individual features. Older lattice-type towers have been associated with high collision risk, as some species exhibiting high fatality rates used the turbine poles as roosts or perches when hunting (Osborn et al., 1998; Thelander and Rugge, 2000). However, in more recent studies, tower structure did not influence the number of bird collisions, as it was not higher than expected according to their availability when compared to collisions with tubular turbines (Barrios and Rodríguez, 2004).

Turbine size has also been highlighted as an important feature, as higher towers have a larger rotor swept zone and, consequently, a larger collision risk area. This is particularly important in offshore sites, as offshore WT tend to be larger than those used onshore. Even so, the relationship between turbine height and bird collision rate is not consistent among studies. In some cases, fatalities increased with turbine height (De Lucas et al., 2008; Thelander et al., 2003), while in others turbine height had no effect (Barclay et al., 2007; Everaert, 2014). This suggests that, like bird abundance, the relationship between turbine height and collision risk may be site- or species-dependent.

Rotor speed (revolutions per minute) also seem to be relevant, as faster rotors are responsible for higher fatality rates (Thelander et al., 2003). However, caution is needed when analyzing rotor speed alone, as it is usually correlated with other features that may influence collision risk as turbine size, tower height and rotor diameter (Thelander et al., 2003), and because rotor speed is not proportional to the blade speed. In fact, fast spinning rotors have fast moving blades, but rotors with lower resolutions per minute may drive higher blade tip speeds.

3.3.2. Blade visibility

When turbine blades spin at high speeds, a motion smear (or motion blur) effect occurs, making WT less conspicuous. This effect occurs both in the old small turbines that have high rotor speed and in the newer high turbines that despite having slower rotor speeds, achieve high blade tip speeds. Motion smear effect happens when an object is moving too fast for the brain to process the images and, as a consequence, the moving object appears blurred or even transparent to the observer. The effect is dependent on the velocity of the moving object and the distance between the object and the observer. The retinal-image velocity of spinning blades increases as birds get closer to them, until it eventually surpasses the physiological limit of the avian retina to process temporally changing stimuli. As a consequence, the blades may appear transparent and perhaps the rotor swept zone appears to be a safe place to fly (Hodos, 2003). For example, McIsaac (2001) showed that American kestrels were not always able to distinguish moving turbine blades within a range of light conditions.

3.3.3. Wind farm configuration

WF layout can also have a critical influence on bird collision risk. For example, it has been demonstrated that WF arranged perpendicularly to the main flight path may be responsible for a higher collision risk (Everaert et al., 2002 & Isselbacher and Isselbacher, 2001 in Hötter et al., 2006).

At APWRA, WT located at the ends of rows, next to gaps in rows, and at the edge of local clusters were found to kill disproportionately more birds (Smallwood and Thelander, 2004). In this WF, serially arranged WT that form wind walls are safer for birds (suggesting that birds recognize WT and towers as obstacles and attempt to avoid them while flying), and fatalities mostly occur

Table 1
Summary of the effectiveness and costs of the avoidance and minimization techniques analyzed and their relationships to the factors influencing risk (+ low; ++ medium; +++ high).

Mitigation strategy	Technique	Short description	Effectiveness	Financial cost	Target bird species/groups	Target collision risk factor
Avoidance	Siting new wind-farms	Strategic planning, pre-construction assessment and EIA Whenever a new wind project is planned	Proven	+ / ++	– All groups and species, with a focus on species vulnerable to collision or endangered species	– Bird abundance – Phenology – Landscape features – Flight paths – Food availability – Wind farm-specific factors
	Repowering	Whenever a new wind project is remodeled and based on post-construction monitoring programs	Proven	+ / ++	– All groups and species. Opportunity to have a new wind farm layout, problematic turbines and areas can be decommissioned	
Minimization	Turbine shutdown on demand	Selective and temporary shutdown of turbines during at risk periods Observers or automatic devices detect birds at risk and selective shutdown of turbines is undertaken	Proven	++ / +++	– All bird species, particularly large birds or during pronounced migratory events	– Bird abundance – Flight paths – Weather – Phenology
	Restrict turbine operation	Turbine shutdown during periods with high collision risk, identified through collision risk modeling	High potential	+++	– Species highly vulnerable to collision or endangered species – Pronounced migratory periods	
	Habitat management	Promote bird activity in areas away from the turbines and decrease bird activity near the turbines	High potential	+ / ++ / +++	– Species with marked preferences regarding habitat selection	– Bird abundance – Food availability – Flight paths
	Increasing turbine visibility	Blades painted with colored patterns or ultraviolet-reflective paint	High potential	+	– Only a limited range of species (not an option for vultures or other species that constantly look down when flying)	– Sensorial perception – Blade visibility
	Ground devices	Conspecific models that attract birds Decoy towers to displace birds	Possible	+ / ++	– Conspecific models may be applicable to social or gregarious species – Decoy towers may be applied for species exhibiting avoidance behaviors for such structures	– Bird behavior – Avoidance behaviors
	Deterrents	Auditory and laser deterrents that displace birds	Possible	++	– May benefit only a small range of species – Lasers applicable only to nocturnally-active birds	– Bird abundance – Flight paths

at single WT or WT situated at the edges of clusters (Smallwood and Thellander, 2004). However, this may be a specificity of APWRA. For instance, De Lucas et al. (2012a) found that the positions of the WT within a row did not influence the turbine fatality rate of Griffon vultures at Tarifa. Additionally, engineering features of the newest WT require a larger minimum distance between adjacent WT and in new WF it is less likely that birds perceive rows of turbines as impenetrable walls. In fact, in Greece it was found that the longer the distance between WT, the higher is the probability that raptors will attempt to cross the space between them (Cárcamo et al., 2011).

3.3.4. Wind farm lights

Lit WT can attract birds, increasing the risk of collision, especially in conditions of poor visibility where visual cues are non-existent and birds have to depend mostly on magnetic compass navigation (Poot et al., 2008). Nocturnally migrating birds can be particularly disoriented and attracted by red and white lights (Poot et al., 2008). In contrast, resident birds seem to be less affected, as they get used to the presence of artificial light and do

not use magnetic compass orientation (Mouritsen et al., 2005). As a consequence, there are records of large fatalities at a variety of lit structures, arising from nocturnal-migrant songbirds being disorientated by lights (Gauthreaux and Belser, 2006). Nevertheless, an analysis of the impact of flashing red lights recommended by the US Federal Aviation Administration did not reveal significant differences between fatality rates at WT with or without flashing red lights at the same WF (Kerlinger et al., 2010).

Bird collisions with lit structures are likely to be more pronounced at sea than on land, and particularly during nights of heavy migration and adverse weather conditions (Hüppop et al., 2006). At an offshore WF in Germany, a high number of bird collisions occurred at a platform that was brightly lit at night (Hüppop et al., 2006).

4. Strategies to mitigate bird collisions

Here, we explore the mitigation options that have been proposed to decrease the risk of bird collisions caused by WF,

categorized in terms of avoidance, minimization and compensation in accordance with best management practice. Fig. 2 represents the number of papers that mention each mitigation measure. The factors presented in Section 3 inform the WF planning process and facilitate the elaboration of mitigation measures. The relationships between collision risk factors and mitigation strategies are outlined in Table 1.

4.1. Avoidance

The most important stage of mitigation is initial WF planning, as WT location is one of the most significant causes of impacts on wildlife. In addition, good early planning could avoid the need for costly minimization and compensatory measures.

4.1.1. Siting new wind farms

Over the years, several national and regional guidelines for WF development that take into account the impact on wildlife have been developed, namely in the USA, Europe and Australia (e.g. Atienza et al., 2012; CEC, 2007; European Union, 2011; SGV, 2012; USFWS, 2012).

At the early stages, WF planning should be conducted from an expanded strategic perspective. Managing WF over a broad geographical area is one of the most effective means of avoiding their impacts on nature (Northrup and Wittemyer, 2013) and is also helpful in reducing the risk of problems at later stages of a project (European Union, 2011).

General opinion is that the most effective way to lessen impacts on birds is to avoid building WF in areas of high avian abundance, especially where threatened species or those highly prone to collisions are present. Therefore, guidance suggests that strategic planning should be based on detailed sensitivity mapping of bird populations, habitats and flight paths, to identify potentially sensitive locations. Based on these recommendations, several sensitivity maps have been developed on a national and regional scale (e.g. Bright et al., 2008, 2009; Fielding et al., 2006; Tapia et al., 2009).

It is important to note that sensitivity mapping does not replace other impact assessment requirements such as SEA and EIA. Local assessments are essential and several authors and authorities have proposed guidelines or standard methodologies to characterize a study area (e.g. Furness et al., 2013; Kunz et al., 2007; Strickland et al., 2011). Bird collision risk is usually estimated during pre-construction surveys and monitoring programs. The most commonly used method to estimate collision rates is the Band collision risk model (Band et al., 2007), which takes into account factors such as flight height, avoidance behavior, ratio aspect and turbine characteristics. Another example is the Bayesian method proposed by the U.S. Fish and Wildlife Service, which provides a standard methodology to predict eagles' fatalities at WF (USFWS, 2013).

Regarding soaring birds, De Lucas et al. (2012b) proposed wind tunnels to perform the WT micro-siting. This approach uses local wind flows and topographic data to build an aerodynamic model to predict the areas more frequently used by soaring birds, and thus determine which areas should be avoided when selecting WT locations.

However, there is a lack of studies comparing prior risk evaluation with subsequent fatalities recorded at an operational WF, which could validate these approaches. The first study that compared predicted versus observed fatalities, Ferrer et al. (2012) found a weak relationship between predicted risk variables in EIA studies in Andalusia, Spain, and actual recorded fatalities, but just for two species – Griffon vultures and Common kestrels. These results suggest that not all factors influencing collision risk are being considered in pre-construction studies. Ferrer et al. (2012) also propose that such factors should be analyzed at the individual WT and not at the entire WF scale, as birds do not move randomly

over the area, but follow the main wind currents, which are affected by topography and vary within a WF.

It is therefore essential to understand why birds collide with WT in order to plan and conduct a comprehensive and appropriate analysis. It is essential at this phase to focus attention at the species or group level, as studying at a broader community level introduces excessive complexity and does not facilitate effective assessment. The analysis should be focused on species susceptible to collisions with WT and also to endangered species present in the study area.

4.1.2. Repowering as an opportunity

WT have a relatively short life cycle (ca. 30 years) and equipment remodeling must be undertaken periodically. Repowering is considered an opportunity to reduce fatalities for the species of greatest concern: (1) WF sites that have adverse effects on birds and bats could be decommissioned and replaced by new ones that are constructed at less problematic sites or (2) WT of particular concern could be appropriately relocated. It is essential that monitoring studies are carried out first, before undertaking such potentially positive steps.

Also, as technology has rapidly progressed in recent years, there is a trend to replace numerous small WT by smaller numbers of larger ones. The main changes have been a shift toward higher rotor planes and increased open airspace between the WT. Despite taller towers having larger rotor swept zones and therefore a higher collision risk area than an old single small WT, there is increasing evidence that fewer but larger, more power-efficient WT may have a lower collision rate per megawatt (Barclay et al., 2007; Smallwood and Karas, 2009). However, repowering has been raising major concern for bats, so a trade-off analysis must be conducted.

4.2. Minimization

Although good planning might eliminate or reduce impact risks, some may persist. In those cases, it is still possible to mitigate them, i.e. decrease the impact magnitude through the implementation of single or multiple measures to reduce the risk of bird collisions with WT. The need for minimization measures (also called operational mitigation) should be analyzed whenever a new WF is being planned and during project operation if unforeseen impacts arise as a result of the post-construction monitoring program.

Here, we analyze the main strategies that have been proposed or implemented in WF to reduce bird fatalities. We also discuss some techniques that are commonly used in wildlife management plans and some strategies we consider important to address when considering the factors influencing bird collisions. We point out that, in general, published evidence of their effectiveness is still lacking.

4.2.1. Turbine shutdown on demand

To date, WT shutdown on demand seems to be the most effective mitigation technique. It assumes that whenever a dangerous situation occurs, e.g. birds flying in a high collision risk area or within a safety perimeter, the WT presenting greatest risk stop spinning. This strategy may be applied in WF with high levels of risk, and can operate year-round or be limited to a specific period.

De Lucas et al. (2012a) demonstrate that WT shutdown on demand halved Griffon vulture fatalities in Andalusia, Spain, with only a marginal (0.07%) reduction in energy production. In this region, WF surveillance takes place year-round, with the main objective being to detect hazardous situations that might prompt turbine shutdown, such as the presence of endangered species flying in the WF or the appearance of carcasses that might attract

vultures (Junta de Andalucía, 2009). Depending on the species and the number of birds, there are different criteria for stopping the WT. However, this approach requires a real-time surveillance program, which requires significant resources to detect birds at risk. In Andalucía, WF surveillance programs use human observers and the number of observers depends on the number of turbines (De Lucas et al., 2012a).

In addition to human observers, there are emerging new independent-operating systems that detect flying birds in real-time and take automated actions, for example radar, cameras or other technologies. These systems may be particularly useful in remote areas, where logistic issues may constrain the implementation of surveillance protocols based on human observers; or during night periods, where human visual acuity is limited in detecting birds. These new systems are based on video recording images such as DTbird® (Collier et al., 2011; May et al., 2012b), or radar technology such as Merlin SCADA™ Mortality Risk Mitigation System (Collier et al., 2011). For example, an experimental design at Smøla WF showed that the DTbird® system recognized between 76% and 96% of all bird flights in the vicinity of the WT (May et al., 2012b). Analyzing the characteristics of these technologies and taking into account factors influencing the risk of collision, cameras can be particularly useful in small WF, for specific high risk WT or when it is necessary to identify local bird movements. Radar systems appear to be a more powerful tool for identifying large-scale movements like pronounced migration periods, particularly during night periods.

Currently, several other systems are under development or being implemented to detect bird-WT collisions or to monitor bird activity close to WT (using acoustic sensors, imaging and radar) (see Collier et al., 2011; Desholm et al., 2006). Hence, it is likely that new automated tools will be available in the future.

4.2.2. Restrict turbine operation

Turbine operation may be restricted to certain times of the day, seasons or specific weather conditions (Smallwood and Karas, 2009). This curtailment strategy is distinct from that described in Section 4.2.1 in that it is supported by collision risk models and not necessarily by the occurrence of actual high risk scenarios. This approach may imply a larger inoperable period and, consequently, greater losses in terms of energy production. As a result, it has not been well-received by wind energy companies.

Based on collision risk models, Smallwood et al. (2007) showed that if all WT in the APWRA area could be shutdown with fixed blades during the winter, Burrowing owl (*Athene cunicularia*) fatalities would be reduced by 35% with an associated 14% reduction in annual electricity generation.

Restrict turbine operation revealed to be very effective for bats. Arnett et al. (2010) showed that reducing turbine operation during periods of low wind speeds reduced bat mortality from 44% to 93%, with marginal annual power loss (<1% of total annual output). For birds it might not be so easy to achieve such results. However, restricting turbine operation could be implemented when particularly high risk factors overlap. For example, WT on migratory routes could be shutdown on nights of poor weather conditions for nocturnal bird migration.

4.2.3. Habitat management

Habitat modification techniques, like vegetation management or the creation of alternative feeding areas, are commonly used in wildlife management plans for sites such as airports (Bishop et al., 2003).

The WF surveillance programs in Andalucía, Spain, include as a prevention measure the location and elimination of carcasses that might attract scavenger species to the WT (Junta de Andalucía, 2009). This practice has also been suggested for vultures by

Martin et al. (2012), who specifies that decreasing the probability of attracting vultures to a WF by reducing food availability near WT or improving foraging areas sited far away should be a high priority.

The high density and high fatality of raptors at APWRA is thought to result from, at least in part, high prey availability (Smallwood et al., 2001). This has led to the proposal of controlling prey populations in the immediate vicinity of WT as a minimization measure. However, the effects of a widespread control program would have collateral effects on other species (Smallwood et al., 2007).

There are other examples of habitat management practices, but these are carried out at a smaller scale than that proposed at APWRA. A management plan had been implemented at Beinn an Turic WF in Scotland, where Golden eagles occur. It aimed to reduce the risk of collision by reducing prey availability within the WF and by creating new areas of foraging habitat away from the WF, increasing the abundance of the eagles' potential prey. Results from 1997 to 2004 showed that eagles tended to use the managed area more frequently, but the results failed to demonstrate a reduction in collision risk (Walker et al., 2005).

In Candeeiros WF, Portugal, a 7-year post-construction monitoring program (2005–2012) revealed a high fatality rate of Common kestrels and showed that birds frequently used the areas near the WT for foraging, as these open areas that are more suitable for searching for prey when compared to the highly dense scrub typical of the vicinity. A mitigation plan involving habitat management was proposed and has been implemented since 2013, which aims at promoting a shift in the areas used by kestrels for foraging by planting scrub species in the surroundings of turbines and the clearance of shrub areas through goat grazing in areas far from the WT (Bio3, 2013; Cordeiro et al., 2013).

4.2.4. Increasing turbine visibility

Although the efficiency of increasing turbine visibility has not yet been demonstrated in the field, laboratory experiments show encouraging results for such techniques. Various attempts to increase blade visibility and consequently reduce avian collision have been made by using patterns and colors that are more conspicuous to birds. Based on laboratory research, McIsaac (2001) proposes patterns with square-wave black-and-white bands across the blade to increase their visibility, and Hodós (2003) proposes a single black blade paired with two white blades as the best option.

As some birds have the ability to see in the ultraviolet spectrum (Bennett and Cuthill, 1994; Hart and Hunt, 2007; Jacobs, 1992), ultraviolet-reflective paint has been suggested for increasing blade visibility. Although this method has proved to be effective in avoiding bird strikes against windows (Klem, 2009), its applicability in WF remains to be proven (Young et al., 2003). However, this may not be an option for raptors, as recent findings pointed out that raptors like Golden eagle or Common buzzard likely are not sensitive to ultraviolet (Doyle et al., 2014; Lind et al., 2013).

Additionally, Martin (2012) suggests that the stimuli used to draw attention to an obstacle, such as a WT, should incorporate movement and be large, i.e. well in excess of the size calculated to be detectable based upon acuity measures.

4.2.5. Ground devices

Martin et al. (2012) argued that increasing the conspicuousness of man-made obstacles would only marginally reduce collision risk because the obstacles are often simply not seen by foraging birds. Based on avian sensory ecology and on the idea that birds are more likely to be looking down and laterally rather than forwards when foraging, Martin (2012) proposes that specialists should find ways to “warn” birds well in advance. For example, he suggests using

devices on the ground, such as models of conspecifics, that “divert” or “distract” birds from their flight path.

However, the effectiveness of these tools is inconclusive. Experimental studies with Common eider (*Somateria mollissima*) in Denmark involving the placement of models of conspecifics at different distances from the WT and based on the principle that birds are more likely to settle where conspecifics are located show that birds avoided flying close to and within the WF (Guillemette and Larsen, 2002; Larsen and Guillemette, 2007). Although this avoidance was not an evident effect of the conspecific models, but was more likely caused by the presence of the turbine structures themselves (Larsen and Guillemette, 2007).

The use of decoy towers (rotorless structures used as obstacles placed around the WF) has also been suggested as an option to keep birds away from WT in the APWRA. However, it has raised some concerns in that it might also attract birds to the general area of the WT or encourage them to remain for longer periods (Curry and Kerlinger, 2000; Smallwood and Karas, 2009). Currently, there are no data regarding their effectiveness. We assert that the efficacy of decoy towers is likely to be limited to the species displaced by WT, which are necessarily less prone to collisions. Also, it is necessary to address that additional structures may arise additionally impacts, both on birds and other groups, in terms of habitat loss and barrier effects.

4.2.6. Deterrents

Deterrent devices that scare or frighten birds and make them move away from a specific area have been broadly used as tools for wildlife management. Auditory deterrents are considered the most effective, although their long-term use has been proven to be ineffective due to habituation by birds to certain stimuli (Bishop et al., 2003; Dooling, 2002). Bioacoustic techniques are thought to be the most effective because they use the birds' natural instinct to avoid danger (Bishop et al., 2003). Preliminary data on the use of the acoustic deterrent LRAD (Long Range Acoustic Device) in WF showed that 60% of Griffon vultures had strong reactions to the device, and its efficacy depended on the distance between the bird and the device, the bird's altitude and flock size (Smith et al., 2011).

Laser deterrents have also been suggested as relevant tools to deter birds during night-time and have been considered a mitigation option for WF (Cook et al., 2011).

Deterrents can also be activated by automated real-time surveillance systems as an initial mitigation step and prior to blade curtailment (May et al., 2012b; Smith et al., 2011). Systems such as DTbird® or Merlin ARS™ incorporate this option in their possible configurations.

Although results are preliminary, we consider that this type of methodology may have an unpredictable effect on the flight path of a bird, so caution is needed if it is applied at a short distance from a WT or within a WF. Nevertheless, it may be used as a potential measure to divert birds from flying straight at a WT.

4.3. Compensation

Although a detailed discussion of this complex subject is not within the scope of this review, we present a general overview of this topic. In compliance with the mitigation hierarchy, the general consensus is that compensation should be a last resort and only considered if the first steps of the mitigation hierarchy (avoidance and minimization) do not reduce adverse impacts to an acceptable level (e.g. Langston and Pullan, 2003).

In broad terms, compensation can be achieved through: (1) enhancing bird populations by acting on biological parameters that influence population levels and (2) minimizing other impacts by influencing other human actions that limit bird populations. The

actions to be implemented should be selected based on the limiting factors that affect the target species population in each area.

Some examples of actions for enhancing populations are: (1) habitat expansion, creation or restoration (reproduction, foraging or resting areas); (2) prey fostering; (3) predator control; (4) exotic/invasive species removal; (5) species reintroductions; and (6) supplementary feeding (e.g. CEC, 2007; Cole, 2011; USFWS, 2013).

Minimization of other impacts can be achieved by: (1) applying minimization measures to human infrastructures besides the WF, such as existing power lines, roads or railways; (2) minimizing human disturbance in key habitats; and (3) awareness campaigns to educate hunters/lawmakers/landowners (e.g. CEC, 2007; Cole and Dahl, 2013; Cole, 2011; USFWS, 2013).

In the USA, governmental entities propose a compensatory mitigation approach for eagles species affected by WF that follows the “no net loss” principals at local and regional scales. The evaluation of impacts is performed at a project level, and its cumulative effect with other sources is also determined. If a wind project exceeds the thresholds defined for a certain area compensation should be implemented (USFWS, 2013).

5. Future research: what is left to understand

Nowadays, wildlife researchers and other stakeholders already have a relatively good understanding of the causes of bird collisions with WT. Through our extensive literature review, we have been able to identify some of the main factors responsible for this type of fatality and acknowledge the complexity of the relationships between them.

From the factors described in Section 3, we find that lighting is the one least understood, and further studies should address this topic by testing different lighting protocols in WT and their effects on bird fatalities, with a special focus on migratory periods during bad weather conditions.

We also anticipate that the expansion of WF to novel areas (with different landscape features and bird communities) or innovative turbine technologies may raise new questions and challenges for the scientific community. This is currently the case for offshore developments. To date, the main challenge in offshore WF has been the implementation of a monitoring plan and making accurate predictions of collision risk due to the several logistical constraints. The major constraints include assessing accurate fatality rates, as it is not possible to perform fatality surveys, and studying bird movements and behavior at an offshore WF, since this usually implies deployment of automatic sampling devices, such as radar or camera equipment (e.g. Desholm et al., 2006).

Due to the complexity of factors influencing collision risk, mitigating bird fatality is not a straightforward task. Mitigation should therefore be a primary research area in the near future. As species-specific factors play an important role in bird collisions, specialists should ideally strive to develop guidance on species-specific mitigation methods, which are still flexible enough to be adaptable to the specificities of each site and WF features.

Appropriate siting of WF is still the most effective measure to avoid bird fatalities. Since there are no universal formulas to accomplish this, it is essential to fully validate the methodologies used to predict impacts when planning a new facility and when assessing the environmental impact of a forthcoming project. In this context, comparing prior risk evaluations with the fatalities recorded during an operational phase should be a priority.

In many cases, pre-construction assessments may be sufficient to prevent high bird fatality rates but in others, it will be essential to combine this approach with different minimization techniques. Political and public demand for renewable energy may prompt authorities and wind energy developers to implement WF in areas

that pose risks to birds. In these cases, minimization techniques are a crucial element for limiting bird fatalities.

In this context, the development of efficient mitigation techniques that establish the best trade-off between bird fatality reduction, losses in energy production and implementation costs is a high priority. Although turbine shutdown on demand seems to be a promising minimization technique, evidence of its effectiveness in different areas and for different target species is lacking. In addition, research should also focus on other options, as in certain situations less demanding approaches may also achieve positive results.

It is also important to ensure that the monitoring programs apply well designed experimental designs, for example a Before-After-Control Impact (BACI) approach (Anderson et al., 1999; Kunz et al., 2007; Strickland et al., 2011). BACI is assumed to be the best option to identify impacts, providing reliable results. However, some constraints have been identified and there are several assumptions that need to be fulfilled to correctly implement these types of studies (see Strickland et al. (2011) for a review on experimental designs).

Finally, it is important to ensure that monitoring programs are implemented and that they provide robust and comprehensive results. Also, monitoring programs results, both on bird fatalities and the effectiveness of the implemented mitigation measures, should be published and accessible, which is not always the case (Subramanian, 2012). Sharing this knowledge will facilitate the improvement of the mitigation hierarchy and the development of WF with lower collision risks.

Acknowledgements

We would like to thank Todd Katzner and an anonymous reviewer, for comments that improved this manuscript, and David and Laura Wright for proof-reading. This study is part of the R&D project, Wind & Biodiversity, co-financed by the national program of incentives for the Portuguese businesses and industry QREN (in the scope of its R&D incentive program), under the operational program *Mais Centro*, and with the support of the European Regional Development Fund.

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Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)**
Notice: **Draft Environmental Impact Statement for the
Proposed Midwest Wind Energy Multi-Species Habitat
Conservation Plan**

For related information, [Open Docket Folder](#) 

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Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0007

Tracking Number: 1jz-8kht-mb7z

Document Information

Date Posted:

Aug 11, 2015

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Comment

please stop allowing lion skins heads or any animals to be
dead and exported to and from us the death of cecil is just
one of millions please ban this at once kandace andriadis
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Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

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Aug 11 2015, at 11:59 PM ET

ID: FWS-R3-ES-2015-0033-0005

Tracking Number: 1jz-8kfr-ja7t

Document Information

Date Posted:

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Comment

To: The U.S. Fish and Wildlife Service

We wish we could have been at the meeting held in Madison but question why such an important issue like this could not be in other areas of the state as well, instead of one place for two hours. We write this in hopes that this will be read and that our effort was not a waste of time. We want to thank The American Bird Conservancy for filing the law suit so that we do have a chance to give some input. Sadly, we would not have to write this if it wasn't for the tax credits and subsidies that we as tax payers pay to be the life line to support the wind industry. We are very concerned when in your Multi-Species Habitat Conservation Plan it states you are planning partners for commercial energy development. In other words we fear our aviary species are the losers through this partnership. We question if it is just a smoke screen to show some type of effort by having one meeting in each state. Your department should have been compiling data and researching this issue, especially from scientists who do not work for the wind industry. If the research had been done correctly, there is an open mind to the truth, and one is not swayed by big money or the false information from the wind industry, our eco system would be the winners. The statement that the wind industry is an important source of clean and renewable electric power makes us sick, for this industry is NOT eco-friendly, is the most costly, and is our poorest form of producing electricity.

All of our birds are an extremely important part of our eco system but in this letter we will address our bats. In San Diego, on February 7th, 2008, at the Wind Power Finance Summit came this statement: "Bat problems are turning out to be a serious issue. Fifty or sixty kills per turbine are significant numbers and are causing concern. Fortunately, bats are not charismatic creatures, so this doesn't carry any weight." This shows with a comment such as that, they do

not care about our bats or how extremely important they are in keeping an eco-friendly balance in our environment. A single bat can eat up to 1,200 mosquito-sized insects in one hour with a total of 6,000 to 8,000 a night! God created the bats as one way to naturally help control our insects. Many people want or need to eat organic food and there are studies which show people with diseases such as cancer and autoimmune diseases should eat only organic food. The destruction of bats means our crops need to be sprayed with chemicals to kill these insects. We live 10 minutes from a wind farm and have friends who live within this farm. One had bat houses that are no longer occupied and every one complains about the increase in mosquitoes since the turbines came.

With the wind industry hiring firms to conduct studies and reporting their results, we believe that the true numbers are NOT being reported. Allowing the wind industry to hire and report results is like having the fox count the chickens in the chicken coop! If you do independent research, you would find that the noise and acoustic problems are reported differently from what the wind industry reports. We are concerned that even if someone delivered a semi truck load of documents showing that the wind industry is not environmentally or economically good, you have already decided to support this industry. WE TRULY HOPE WE ARE WRONG IN FEELING THIS WAY. Scientist call the wind industry the "WORLDS BIGGEST SCAM" and we're afraid we're going to continued to be scammed! We ask PLEASE protect our birds, protect our environment and people and not follow after the lies and big money.



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

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ID: FWS-R3-ES-2015-0033-0006

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Document Information

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Comment

A 45 year period for incidental take permits is too long: we don't yet fully understand the scope of the impact wind turbines have on avian species, especially bats, whose populations have plummeted in recent years because of habitat loss, pesticide use, water pollution and White Nose Syndrome. I oppose granting incidental take permits for wind turbines.



Submitted Electronically via eRulemaking Portal

This is a Comment on the **Fish and Wildlife Service (FWS)** Notice: **Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan**

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ID: FWS-R3-ES-2015-0033-0004

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Document Information

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Comment

See attached file(s)

Attachments (1)

[USFW HCP](#)

View Attachment:



July 29, 2015

Regional Director
Attn: Rick Amidon
U.S. Fish and Wildlife Service
Ecological Services
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

Re: Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan, Docket No. FWS-R3-ES-2015-0033

The Nature Conservancy would like to thank the U.S. Fish and Wildlife Service for the opportunity to provide comments on the notice of intent to prepare an Environmental Impact Statement (EIS) for the proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan (MSHCP). The Nature Conservancy is a national and global non-profit conservation organization whose mission is to conserve the lands and waters on which all life depends. Our on-the-ground conservation work is carried out in all 50 states and over 30 foreign countries and is supported by approximately one million members. The Conservancy does this work in collaboration with individuals, local communities, businesses, public agencies, and other nonprofit groups. We work closely with farmers, ranchers and other landowners, and own and help manage large areas of land across the country. We are a science-based organization with over 550 scientists supporting our work across the United States and around the world. Since 1951, the Conservancy and its members have protected more than 119 million acres of land and 5,000 miles of river around the world. The Conservancy previously provided comments on the scoping for the MSHCP in November, 2012; a copy of those prior comments is attached to this letter for reference.

The Conservancy would like to reiterate our position, expressed in our November, 2012, letter that the MSHCP should reflect the principles of the mitigation hierarchy that meet a high standard. These principles are expressed in McKenney and Wilkinson (2015) and are summarized in Attachment I. Central to these principles is the need to follow the hierarchy sequentially and first avoid impacts to the covered species to the maximum extent practicable. One of our concerns in this regard, based on our review of the material available about the MSHCP at www.midwestwindenergyhceis.org, is the extent of the covered lands in relation to known wind-sensitive conservation areas as shown on the map "Figure 1-4. Covered Lands within the MWE MSHCP Plan Area." While we commend the Service and the Plan partners for specifically excluding a variety of areas that we and others previously identified as important for avoidance, we feel that additional geographies should be excluded from coverage under this plan in order to fully meet the avoidance goals of the mitigation hierarchy for this project.

The additional geographies we suggest for exclusion from the covered lands in the MSHCP fall into two categories: (1) areas specific to the covered species and (2) general areas of conservation importance that should be excluded from wind development in each state in the Plan area. In regards to the covered species, we strongly recommend that known areas of Kirtland's Warbler (*Setophaga kirtlandii*) breeding habitat in Michigan (both Lower and Upper Peninsula) and Wisconsin be excluded from

coverage under the plan. These areas would include identified Kirtland's Warbler Management Areas plus a suitable buffer distance around them and habitat identified as suitable for possible population expansion in the future. These areas should be identified by the project proponents in conjunction with the Service, USDA Forest Service, Michigan Department of Natural Resources, and Wisconsin Department of Natural Resources.

The Conservancy also recommends very strongly that the Service and project proponents engage other federal and state agencies and conservation partners to identify more broadly areas of general conservation importance that are sensitive to wind development and exclude these areas from coverage under the Plan. We feel that this is a critically important step in implementing the avoidance component of the mitigation hierarchy. Avoidance is the best way to ensure that covered species are not harmed, whereas minimization and compensatory actions carry with them the risk that they will fail either to be carried out or to meet conservation objectives. In addition, avoidance will reduce the potential for future conflicts between wind energy and natural resources, and will lessen the potential for endangering or threatening other species at national or state levels. Several states in the Plan Area have developed or are working on guidance on areas of sensitivity to wind power for environmental resources of conservation concern. For example, partners in Indiana have developed a map of wind power development sensitive areas which should be considered for exclusion under the Plan (Attachment II). The Ohio Department of Natural Resources' Division of Wildlife has developed guidelines for pre- and post-construction wildlife monitoring and has developed a map stratifying the state into areas recommended for minimum, moderate, and extensive wildlife surveys (available at wildlife.ohiodnr.gov/species-and-habitats/fish-and-wildlife-research/wildlife-and-wind-energy). Similar guidance on minimizing the impact of wind energy development on wildlife, maps of sensitive areas, or both is available from the Wisconsin Department of Natural Resources (dnr.wi.gov/topic/Sectors/Wind.html), Minnesota Department of Natural Resources (www.dnr.state.mn.us/eco/ereview/additional_resources.html), and Iowa Department of Natural Resources (www.iowadnr.gov/Environment/WildlifeStewardship/NonGameWildlife/Conservation/WindandWildlife.aspx).

The Conservancy also suggests that grasslands in which the Greater Prairie-Chicken (*Tympanuchus cupido*) is known to occur or that might possibly be reintroduction sites for this species be excluded from the Plan's covered lands. The prairie grouse as a group are known to be intolerant of habitat fragmentation and are particularly sensitive to the presence of tall structures, which create an avoidance effect of habitat that might otherwise be suitable (McNew et al. 2014, Winder et al. 2015). The Greater Prairie-Chicken currently occurs in five of the states in the Plan area (Illinois, Iowa, Minnesota, Missouri, Wisconsin) and considerable efforts have been made in those states to preserve or restore habitat and reintroduce the birds themselves. A cursory comparison of Figure 1-4 and recent maps of the prairie-chicken's distribution (e.g., www.grousepartners.org/prairie-grouse/) suggest that most of the current range is now considered as covered lands by the Plan. The closest relative of this species, the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*), was recently listed as Threatened by the Service and we see little reason why the Greater Prairie-Chicken will not follow the same listing path if important conservation measures such as avoidance of wind development in its habitat are not implemented immediately.

The Conservancy would also like to express its view that, whenever and wherever possible, wind energy development under this Plan should be located in existing disturbed areas. Recent research by Conservancy staff and colleagues has shown that sufficient already disturbed lands exist in many parts of the country that could be used to site wind facilities and thereby produce the wind power needed now and in the future (e.g., Kiesecker et al. 2011, Fargione et al. 2012). For example, an analysis of the

degree to which disturbed lands could be used to meet the Department of Energy's goal of 20% of the nation's electricity produced by wind by the year 2030 (DOE 2008) showed that for five of the states in the Plan area, wind power produced only from disturbed lands could meet or vastly exceed the DOE goal for that state (Kiesecker et al. 2011). Only in one state (Michigan) was the goal not exceeded but, even there, 53% of the goal could be met from wind power produced on disturbed lands (note that two states in the Plan area, Missouri and Ohio, were not analyzed in this work). A similar analysis using a slightly different methodology more focused on state-specific avoidance areas found that disturbed lands could generate over 35% of the projected wind power goals, albeit in a windier region further west than the Plan area (Fargione et al. 2012). Therefore, the Conservancy continues to be a strong advocate of siting wind power in disturbed areas with minimal impact to wildlife resources.

In alignment with Principle 4 from McKenney and Wilkinson (2015), we would like to remind the Service and its partners that there are limits to what can practically be offset for the covered species. As discussed in that document (see also Attachment I) and in the recent literature (e.g., Bull et al. 2013, Gardner et al. 2013), compensatory offsets for unavoidable take of the covered species must be carefully designed so that they do, in fact, result in a measureable no net loss of the covered species. Numerous factors contribute to the actual or potential failure of offsets to address take of species, including outright failure of some offset projects, lack of opportunities to implement offset projects, and time lags between when projects are implemented and when they actually produce "uplift" of the species they are designed to benefit. The Conservancy looks forward to working with the Service and its partners to assist in the design and implementation of appropriate compensatory offset projects for the covered species, should they be needed.

The Conservancy continues to agree with the inclusion of the proposed bat species as covered species under the proposed MSHCP. The Conservancy strongly encourages the Service to require operational mitigation measures to reduce bat mortality at all installed turbines such as those recommended by Arnett et al. (2011, 2013), AWWI (2015), and Baerwald et al. (2009). However, the Conservancy sees a significant need for continued research related to white-nose syndrome (WNS) and bats, as well as research to identify the most effective conservation strategies and management recommendations to address both the impacts of WNS as well as protecting bat habitat generally, including areas where bats may concentrate during migration. WNS is one of the primary threats to the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and little brown bat (*Myotis lucifugus*) and should be the focus of the majority of conservation funding and efforts in the MSHCP. Therefore, we urge the prioritization of funding and research to increase monitoring efforts and work to improve our understanding of forest habitat requirements and habitat use by all three bat species, as well as to improve our understanding of how various management activities impact these species and others affected by WNS.

The Conservancy would also like to reiterate our call from our 2012 comments for a robust monitoring and adaptive management program to be part of the Plan. Such monitoring and management will be the key to the success of the implementation of the mitigation hierarchy in this MSHCP and to determine if the minimization and compensation strategies employed are actually working. The Conservancy recommends that the Service and its partners in the Plan look toward existing models of cooperation between State wildlife agencies and the wind industry, such as the one developed in Pennsylvania (www.portal.state.pa.us/portal/server.pt/gateway/PTARGS_0_0_136886_0_0_43/http://pubcontent.state.pa.us/publishedcontent/publish/marketing/sites/game_commission/content/wildlife/habitat_management/wind_energy/wind_energy_home_ci.html?qid=68608663&rank=7), for how to implement and collect data for a comprehensive pre- and post-construction bird and bat monitoring program. As part of implementing an adaptive management strategy, we recommend that the MSHCP include a schedule

for regular updating and revision based on the monitoring data collected, perhaps as often as every five years or when important new data is obtained on the covered species.

The Conservancy appreciates this opportunity to provide input on the scoping for the EIS for the proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan. We look forward to working with the Service and its many partners the development of this significant project to implement wind energy development in the Midwest. Please do not hesitate to contact us if you require any additional information or assistance with this matter.

Sincerely,
Scott Davis
Director of Conservation Programs, US Central Division
The Nature Conservancy

August 11, 2015

U.S. Fish and Wildlife Service, Ecological Services,
Attn: Rick Amidon,
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

Re: MSCHP - Public Scoping Meeting Comments

Dear Mr. Amidon,

This letter is in response to your request for comments regarding the Public Scoping Meeting held in Indianapolis, IN on July 22, 2015. The comments are as follows:

- Bird exclusion area along the northwestern border of Indiana/Illinois should be extended/widened into Indiana to include important migratory bird routes within northwestern Indiana.
- Extend the exclusion area around Lake Michigan to include not only the land but also over the lake as well since many birds migrate off-shore.
- Extend/widen the exclusion area for the Wabash Corridor.
- Expand exclusion areas beyond the river corridors to include blocks of habitat for migratory birds, especially at high concentration areas. A prime example is: Jasper-Pulaski Fish and Wildlife Area is a major staging area where thousands of cranes have been noted using agricultural fields. Large concentrations of migratory waterfowl use Gibson Lake and all the agricultural fields in between and around the lake and the Wabash River. Additional areas can be provided upon request.
- The migrant trap in NW Indiana should be added to the excluded lands. It is a green space bordering Lake Michigan immediately west of the Hammond marina. See attached Map.
- Elaborate on monitoring as a covered activity under the HCP. It's broadly stated as "site, design, and construction monitoring, operations monitoring, mitigation monitoring and effectiveness monitoring". Clarify that it includes pre/post construction surveys, siting, and mortality searches as required monitoring activities.
- Elaborate on "management of compensatory mitigation lands". Does this include off-site, on-site, species-specific?

Rick Amidon, MSHCP - Public Scoping Meeting Comments
August 11, 2015
Page Two

- Reduce the proposed permit term (45 years). As written, proposed and existing projects may apply for and receive take authorizations during the first 15 years. Reduce the period on front end which will shorten the total permit term.
- Remove little brown bats, *Myotis lucifugus*, from the covered species list.
- Include migratory tree bats on the covered species list.

Our agency appreciates this opportunity to be of service. Please do not hesitate to contact Erin Basiger, Statewide Environmental Biologist, at (317) 234-0586 or ebasiger@dnr.in.gov for further details on these comments.

Sincerely,

A handwritten signature in black ink that reads "Erin Basiger". The script is cursive and fluid.

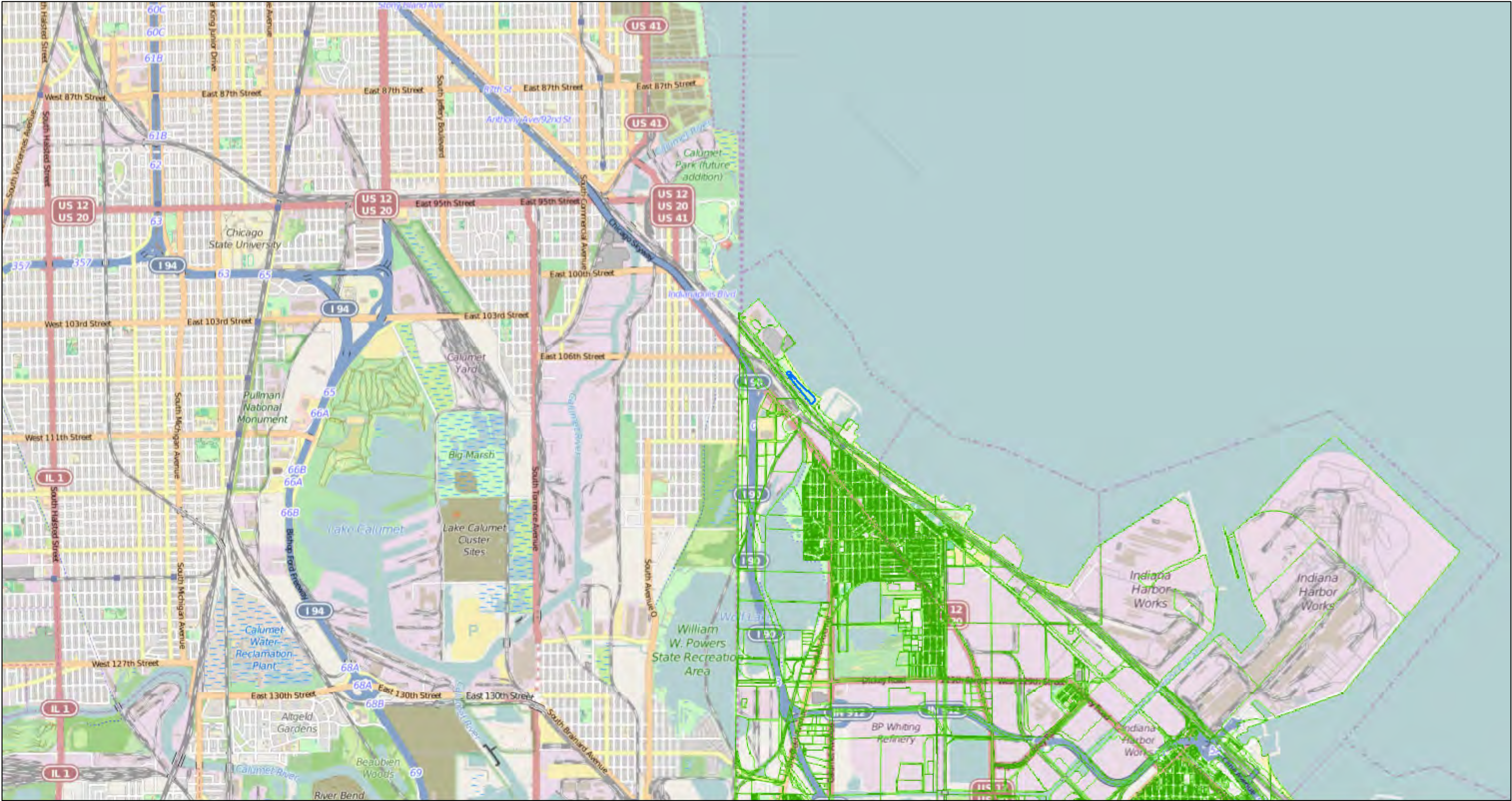
Erin Basiger
Statewide Environmental Biologist

Enclosures: Migrant Trap Map
Migrant Trap2 Map

This map shows the Lake County, Indiana area, focusing on the Indiana Toll Road (I-90) and the Indiana State Line Road. The map includes various streets such as South Avenue C, South Avenue B, South Avenue A, and South Avenue D. It also shows the location of Lakefront Park, a large green area, and the Lake County Courthouse. The map is oriented with North at the top.

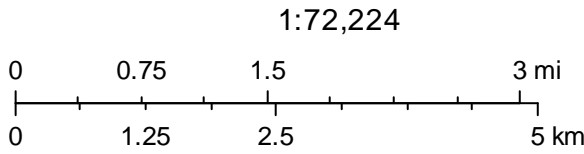
A horizontal scale bar with tick marks at 0, 0.1, 0.175, 0.2, 0.35, 0.4 mi, and 0.7 km. The text '1:9,028' is centered above the bar.

Migrant Trap



July 23, 2015

- State Parcels (owned/managed) : : : October 2010
- : : : September 2014
- : : : August 2014
- : : : July 2014
- : : : June 2014
- : : : July 2013



Indiana Geographic Information Council (IGIC), Indiana Office of Technology (IOT), Indiana Geographic Information Office (GIO), Indiana Department of Homeland Security (IDHS), Indiana Geological Survey (IGS) and participating Indiana counties, Indiana Data Sharing Initiative



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 11 2015

REPLY TO THE ATTENTION OF:

E-19J

Rick Amidon
U.S. Fish and Wildlife Service
5600 American Blvd. West, Suite 990
Bloomington, Minnesota 55437-1458

**RE: Midwest Wind Energy Multi-Species Habitat Conservation Plan – Scoping Comments
(Docket Number FWS-R3-ES-2015-0033)**

Dear Mr. Amidon:

The U.S. Environmental Protection Agency (USEPA) is sending this letter in order to share our scoping comments with the U.S. Fish and Wildlife Service (USFWS) concerning the forthcoming Midwest Wind Energy Multi-Species Habitat Conservation Plan (Midwest Wind Energy HCP) and Draft Environmental Impact Statement (Draft EIS). Our comments are provided pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508), and Section 309 of the Clean Air Act.

Both President Obama's National Policy (The White House 2010) and renewable portfolio standards set by several Midwestern states call for aggressive growth in renewable energy sources, which includes wind energy. Even though wind turbines are a clean, renewable means to generate power, they cause mortality of birds and bats that are struck by or pass near turning wind turbine blades. When wind energy development has the potential to impact species listed under the Federal Endangered Species Act (ESA), an "incidental take permit" (ITP) under Section 10 of the ESA must be obtained from USFWS. To obtain such a take permit, a Habitat Conservation Plan under the ESA and an analysis of environmental impacts under NEPA must be prepared.

Even though individual wind development projects have addressed endangered species issues through required Federal ITPs, and in some cases, state permits, USFWS has determined that a regional solution is needed. In order to provide a regional solution, USFWS is undertaking the development of the Midwest Wind Energy HCP as a collaborative effort among USFWS, state natural resources agencies, and other planning partners within an eight-state Plan Area in the Midwest. The eight Midwestern states included in the Midwest HCP are Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The activities to be covered under the Midwest Wind Energy HCP include the construction, operation, maintenance, and decommissioning of wind energy facilities within portions of the Plan Area where ESA

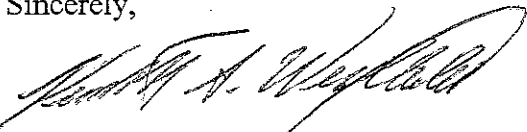
incidental take coverage may be considered, as well as activities associated with the management of mitigation lands.

The Midwest Wind Energy HCP serves as the required HCP and will be accompanied by the Midwest Wind Energy HCP EIS. The Draft EIS will evaluate the impacts of several alternatives related to the potential issuance of ITPs under the Midwest Wind Energy HCP from the aforementioned activities. The ITPs would authorize the incidental take of species included in the Midwest Wind Energy HCP that could occur as a result of existing and future wind energy development and operations. The planning partners intend to request a 45-year permit term.

The intended purpose of the Midwest Wind Energy HCP is to provide conservation benefits to species currently listed under the ESA, as well as species in review for listing, while accommodating future wind development across these eight Midwestern states. Specifically, the planning partners have requested incidental take coverage for eight species in the Midwest Wind Energy HCP, including six species that are Federally-listed, one species that is not federally listed but may become listed during the term of the Midwest Wind Energy HCP, and the bald eagle (*Haliaeetus leucocephalus*). As stated by USFWS, the Midwest Wind Energy HCP will offer an innovative approach to both enhanced conservation of species, streamlined regulatory compliance with the ESA for wind energy projects, and a clearly-defined and predictable regulatory process for wind project operators, and will do so while satisfying applicable provisions of the ESA.

As a result of several telephone conversations in 2015 among yourself and various NEPA staff members from USEPA Regions 5 and 7, which have responsibilities covering the eight states listed above, USEPA offers the enclosed comments for consideration during development of the Draft EIS. USEPA appreciates the opportunity to be engaged in this project early in its development. We are available to discuss our scoping comments and recommendations with if you, and we look forward to engaging in future discussions and reviewing NEPA documents prepared for this activity. If you have any questions about this letter, please contact Kathy Kowal of my staff at 312-353-5206 or via email at kowal.kathleen@epa.gov.

Sincerely,



Kenneth A. Westlake, Chief
NEPA Implementation Section
Office of Enforcement and Compliance Assurance

Enclosure: *USEPA comments concerning USFWS's Midwest Wind Multi-Species Habitat Conservation Plan (Midwest Wind Energy HCP)*

Cc with enclosure (via email):

John Anderson, American Wind Energy Association
Kris Hoellen, The Conservation Fund

USEPA scoping comments concerning USFWS's Midwest Wind Multi-Species Habitat Conservation Plan (Midwest Wind Energy HCP)

August 11, 2015

ALTERNATIVES

- The proposed ITP term is 45 years. In the face of uncertainty, such as the future of white nose syndrome, species that may be listed under the ESA in the future but within the term of the ITP, and the effects of climate change, USEPA requests that the Draft EIS analyze alternatives that utilize a shorter ITP duration (e.g., 10, 15, 20, and 30 years).

COORDINATION

- The Draft EIS should discuss coordination efforts undertaken thus far with other Federal agencies, state agencies, non-profit entities, private industry, and other planning partners. USEPA previously has suggested that, as an example, USFWS coordinate with the Western Area Power Administration, whose service area includes portions of Iowa and Minnesota.
- To the extent practicable, USEPA recommends that USFWS coordinate with public utility commissions during the development of the Draft EIS and Midwest Wind HCP, as this could allow for influence in siting of future turbines.

COVERED ACTIVITIES AND IMPACT ANALYSIS

- The Draft EIS should clearly explain how impacts to state-listed endangered and threatened species will be coordinated. USEPA strongly recommends, in states with a state permitting process for take of endangered or threatened species, that USFWS make receipt of the Federal ITP contingent upon receipt of the state permit (similar to Clean Water Act Section 404 permit approvals being contingent upon a state's granting of Clean Water Act Section 401 Water Quality Certification).
- USEPA is aware that the U.S. Geological Survey (USGS) has been applying expertise in biology, ecology, mapping, and resource assessment to contribute to the U.S. Department of the Interior's "Powering Our Future Initiative" to quantify the impact of wind energy development on birds and bats. In 2015, USGS released a preliminary methodology to assess the population level impacts of onshore wind energy development on birds and bats. This wind energy impacts assessment methodology is the first of its kind, evaluating national to regional scale impacts of those bats and birds that breed in and migrate through the United States. The methodology focuses primarily on the effects of collisions between wildlife and turbines. Tree bats are particularly susceptible to mortality from many ongoing activities, including wind farm construction and wind energy development. EPA strongly recommends that USFWS undertake a status assessment (population viability assessment) for all tree bat species to assess cumulative impacts due to wind energy development and other impacts to tree bats.

- As the “covered activities” of the Midwest Wind Energy HCP will include construction, operation, maintenance, and decommissioning of wind energy facilities within portions of the Plan Area where ESA incidental take coverage may be considered, USEPA recommends the Draft EIS analyze impacts associated with the current (and potential future) range of turbine sizes and designs, considering differences in total heights and blade length. For example, USFWS should analyze impacts by groups by type/size of one power structure design versus another.
- The project vicinity includes lands that provide habitat for whooping cranes. It is possible that migrating whooping cranes may occasionally stopover in several states included in the Midwest Wind Energy HCP. Direct mortality may be unlikely if construction occurs outside of the spring and fall migration periods. Direct mortality may also be unlikely during steady migratory flight, since whooping cranes migrate at an altitude much higher than the rotor-swept area of most turbines. However, there may be potential for collision with turbines and/or project transmission lines during stopover periods when whooping cranes fly between foraging and roosting sites at sunset and sunrise under low-light conditions or during inclement weather. Such conditions, particularly for specific wind farms in Indiana, have led to recent conclusions that the potential for adverse effects to whooping cranes, particularly from turbines, cannot be reduced to discountable or insignificant levels. Should a sandhill crane flock be protected under the ESA, the appropriate determination would be that operation of future turbines would be likely to adversely affect whooping cranes. In areas where even marginal stopover habitat is present, the potential for disturbance and displacement of whooping cranes is possible. Marking power lines reduces collision rates. We recommend that USFWS study areas where marking power lines will reduce adverse effects to whooping cranes using those project area during stopover periods when whooping cranes fly between foraging and roosting sites at sunset and sunrise. USFWS should also discuss how marking power lines will reduce other avian mortality.
- The Draft EIS should discuss if developments permitted under Midwest Wind Energy HCP ITPs will be allowed a maximum number of turbines, or if turbines will be required to be aligned in any specific navigational direction (N/S/E/W) to reduce or manage for bird and bat impacts. The Draft EIS should also discuss if USFWS plans to set density limits for wind developments, including the number of sites will be limited within specific watersheds or airsheds, or if there will be a maximum number of power structures and substations allowed within each wind energy development site under an ITP.
- The Draft EIS should discuss if all existing types of different turbines (e.g., heights, blade widths, etc.) have been field tested to know the impacts associated with each type of turbine. While USEPA understands that a single test turbine (or small-scale installation) may not yield sufficient results to extrapolate long term mortality expectations, small to large scale testing, or installation with requirements for heavier monitoring are recommended (for those turbines not tested).
- The Draft EIS should acknowledge that wind turbines can produce shadow flicker. Impacts associated with shadow flicker and any best practices or standards for shadow flicker minimization should be discussed in the Draft EIS.

ADAPTIVE MANAGEMENT

- Over the 45-year life of the proposed plan, it is likely that the additional species (such as the red bat, the hoary bat, the little brown bat, the eastern small footed bat, etc.) may or will be petitioned to be listed under the ESA. The Draft EIS should discuss what adaptive management plans are in place to consider species that are petitioned in the future during the life of the Midwest Wind Energy HCP.
- The proposed ITP term is 45 years. It is not clear how USFWS can ensure adaptive management is occurring when the permit life is that long. USEPA recommends the Draft EIS study and the ITP require implementation of adaptive management strategies at five-year intervals under the ITP.
- EPA recommends that any permittee that opts into this ITP during the first 15 years of the permit be required to adhere to any changes to the ITP/ Midwest Wind Energy HCP resulting from acquisition of new or additional information, findings, or new protocols implemented after their permit is issued, rather than be grandfathered in without modification. Examples of permit modifications could include:
 - The requirement to implement new technology that may be developed to monitor bird and bat movement around turbines during the duration of the Midwest Wind Energy HCP;
 - Implementation of revised monitoring protocols that may be updated during the duration of the Midwest Wind Energy HCP;
 - Implementation of revised avoidance measures that may be updated during the duration of the Midwest Wind Energy HCP; or
 - Implementation of new or alternate adaptive management techniques updated or implemented during the duration of the Midwest Wind Energy HCP.
- The Draft EIS should discuss how turbine height and blade width, and adaptations to turbine design (and subsequent impacts due to those changes) will be studied during the length of the HCP to adaptively manage for new information.

MITIGATION AND MITIGATION LANDS

- The “covered activities” of the Midwest Wind Energy HCP will include activities associated with the management of mitigation lands. However, mitigation does not allow for reasonable reductions in impacts. As such, USEPA recommends that USFWS, in the Draft EIS, suggest identifying site characteristics for potential mitigation sites (e.g., elevation, contours, and habitat type) that would be optimal or more environmentally beneficial.
- USEPA recommends that portions of USFWS’s Land-Based Wind Energy Guidelines become made a mandatory component of ITPs issued under the Midwest Wind Energy HCP. Specifically, USEPA recommends the following measures be mandatory for all permittees:
 - Installation of motion-detection lights in turbine nacelles that will shut off automatically after a pre-determined amount of time when no human movement is detected. It is the inadvertent mistake of human error [leaving lights on] that led to episodes of high bird mortality, such as the September 2011 mortality event at the Mount Storm Wind Energy

Facility in West Virginia. Installation of motion-detector lights decreases the likelihood of this type of human error, and as such, is more protective of migratory birds;

- Installation of white strobe lighting on meteorological towers (MET towers) to reduce avian mortality. Direct avian mortality has been a primary impact associated with MET towers depending on tower height, lighting, color, structure, and the presence of guy wires. According to The Ornithological Council, white strobe lighting typically results in the lowest mortality rate;
- Equipping all project substations with downward-facing shields on all lights to reduce avian mortality; and
- Marking all power lines to reduce avian mortality.

MONITORING

- The Draft EIS should clearly discuss what each applicant is responsible for with regard to monitoring and reporting, including expected protocols.
- The Draft EIS should discuss if USFWS plans to develop pre- and post-construction monitoring and reporting guidance, which would enhance usability of data from individual wind projects.
- Wind energy operators regularly conduct surveys for wildlife carcasses beneath wind turbines to estimate the number of animals killed from collisions with turbines. Finding zero carcasses does not provide assurance that no animals were killed because carcasses may have been scavenged or missed in the searches. USGS scientists have developed a method and software (“Evidence of Absence”) to statistically evaluate the search process to determine how many animals may have been killed. Wildlife managers can use the method to design monitoring protocols and to determine whether a zero count really means “zero killed” or “none found.” Precise estimates of numbers of endangered species killed are important because overestimating mortality may lead to costly and unjustified mitigation whereas underestimating does not accurately account for impact to a species. USEPA strongly recommends that USFWS require the use of “Evidence of Absence” software for estimating bird and bat fatalities at wind farms and for designing search protocols approved by USFWS as part of required monitoring.
- The State of Ohio has its own protocols for monitoring at on-shore wind energy facilities, including their Monitoring Protocol for Commercial Wind Energy Facilities in Ohio and Post Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio. USEPA understands that Ohio’s protocols have led to discoveries that species takes are occurring not only in the fall (when monitoring typically occurs), but in the spring as well. This is likely due to bat and bird migration in both directions (spring and fall migrations). USEPA recommends the Draft EIS discuss existing state protocols for monitoring and how they have, or have not, been utilized in USFWS’s monitoring recommendations and requirements.

C G Spies
PO Box 171
Pequabuck CT 06781

17 June 2015

Attn: Rick Amidon
Regional Director, Ecological Services
US Fish and Wildlife Service
Ste. 990, 5600 American Blvd W
Bloomington MN 55437

Re: FWS-R3-ES-2015-0033, Draft Environmental Impact Statement for the Proposed Midwest Wind Energy Multi-Species Habitat Conservation Plan, 113 FR 33537-33540

Please send me a copy (preferably paper, not CD) of the DEIS when it is available.

I am greatly troubled by the direction of this and similar proposals which will apparently sanction the killing of migratory birds and other protected species during the routine use of these facilities. Perhaps I'm wrong, but it's my understanding that when there is a proposal to disturb, displace, or destroy endangered species during the construction of a residence, there are requirements to minimize the disturbance, displacement, and destruction, and to compensate for these actions that occur during construction, but that there is no ongoing, continuing permission to further disturb, displace, or destroy endangered species while the residence is occupied. It is one thing to permit disturbance, displacement, or destruction of endangered species or migratory birds while a wind turbine is being constructed or decommissioned, and to arrange for reasonable mitigation to compensate for resource losses, but quite another thing to permit killing and maiming of birds and other animals during routine operation and maintenance of a wind turbine. In my opinion, FWS should be in the business of protecting wildlife, and not in the business of permitting their entirely foreseeable destruction.

FWS should fix a dollar value, a punitive dollar value, on every migratory bird, endangered species, eagle, etc., for which FWS is responsible, and require a payment from the wind turbine operator or owner (or, for that matter, the owner or operator of any other industrial structure) for each killed or maimed animal. This value should be set to increase as the number of killed or maimed animals increases.

Monitoring should be required at every site, paid for by the turbine operator, but supervised by FWS, to account for mortality and injury to wildlife, including estimates to account for losses to scavengers.

The turbine operators and owners should be encouraged to adjust turbine operations to avert mortality, and to research methods to avoid mortality entirely. A hefty punitive fine may be the best incentive to encourage less destructive operation of wind turbines.

The levels of mortality and injury that have been documented and estimated at wind turbines are so cumulatively large that it is not reasonable to call such take "incidental". Such take is neither trivial nor accidental, and it should not be condoned by FWS through the issuance of permits. Let the industry employ methods to avoid this mortality, or require compensation for the destruction of this resource.



C G Spies

Stevens, Kimberly

Subject: FW: USFWS scoping for Midwest Wind Multi-Species Habitat Conservation Plan for wind projects in the Midwest
Attachments: EPA comments concerning FWS MWHCP 05212015.docx

From: Amidon, Rick <rick_amidon@fws.gov>

Sent: Thursday, May 21, 2015 12:04 PM

To: Zohn, April; Lentsch, Leo

Cc: Sean Marsan

Subject: Fwd: USFWS scoping for Midwest Wind Multi-Species Habitat Conservation Plan for wind projects in the Midwest

FYI

----- Forwarded message -----

From: Kowal, Kathleen <kowal.kathleen@epa.gov>

Date: Thu, May 21, 2015 at 12:04 PM

Subject: USFWS scoping for Midwest Wind Multi-Species Habitat Conservation Plan for wind projects in the Midwest

To: "Amidon, Rick" <rick_amidon@fws.gov>

Cc: "Pelloso, Elizabeth" <Pelloso.Elizabeth@epa.gov>, "Shepard, Larry" <Shepard.Larry@epa.gov>, "Tucker, Amber" <Tucker.Amber@epa.gov>, "Westlake, Kenneth" <westlake.kenneth@epa.gov>

Rick,

After speaking with my colleagues who could not attend the discussion in March, we've added a few more suggestions for FWS to consider when developing the Plan and the EIS. If you have any questions, please do not hesitate to contact me and I'll get the group together for a call.

We appreciate your efforts to reach out to EPA early in the process.

Kathy

EPA comments concerning FWS Midwest Wind Multi-Species Habitat Conservation Plan (MWHCP)

Comments from Larry Shepard:

- ✓ FWS coordinate with Western Area Power Administration (IA)? FWS not sure, but WAPA could be invited into the loop to see if they have an interest in participating.
- ✓ Range of turbine sizes and designs – consider differences in total heights and blade length. For example, analyze impacts by groups by type/size of one power structure design v. another.
- ✓ How big will the field array be? Fewer impacts associated with compass direction?
- ✓ Density limits (no. of power structures within site, no. of sites within watershed/airshed)?
- ✓ Mitigation will not allow you to make reasonable reductions in impacts; suggest identifying site characteristics (elevation, contour, habitat type) that would be optimal or least environmentally damaging.
- ✓ Monitoring and reporting in tight budget times; project applicant should be responsible to monitor and report to FWS and the public using FWS monitoring protocols.
- ✓ Explicit time limit for usefulness of document? i.e., greater than 10 years since MWHCP released and therefore reasonable life span might necessitate supplement.
- ✓ Need evidence to back-up rationale for impacts associated with different equipment groups.

Comments from Amber Tucker, Liz Pelloso, Kathy Kowal:

- ✓ If any of the following are revised during the duration of a MWHCP, will the MWHCP recipient be required/requested to follow:
 - a) new technology that may be developed to monitor bird and bat movement around turbines during duration of MWHCP?
 - b) revised monitoring protocols that may be updated during duration of MWHCP?
 - c) revised avoidance measures that may be updated during duration of MWHCP?
 - d) adaptive management techniques used by FWS and often reviewed by agency and implemented by wind companies?
- ✓ Will FWS develop pre- and post-construction monitoring and reporting guidance to enhance usability of data from individual wind projects?